ELEMENTARY
CORE Academy
UTAH STATE OFFICE OF EDUCATION & UTAH STATE UNIVERSITY

ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY •

6TH GRADE

PARTICIPANT HANDBOOK
2004

UTAH STATE OFFICE OF EDUCATION

UtahState UNIVERSITY

ELEMENTARY CORE ACADEMY

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Utah State Office of Education (USOE)
Utah State University (USU)
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State Mathematics Education Coordination Committee (SMECC)
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WestEd Eisenhower Regional Consortium

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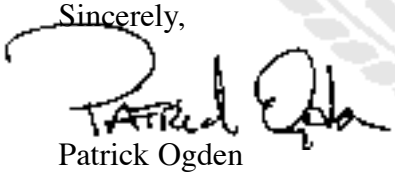
Dear CORE Academy Teachers:

Involvement in the CORE Academy represents a significant investment by you, your school, and district in educational excellence for the students of Utah. The goal of the Academy is to provide a high quality opportunity for teachers to engage in meaningful professional growth.

The Academy will help you gain expertise in the collection and use of accurate data and analysis of each student's level of achievement, teach sound instructional methods specifically aligned to the state Core Curriculum, and provide an opportunity for collegial support.

I commend you for your dedication and willingness to engage in meaningful professional development. It is my belief that educators care deeply about their students and work hard to create successful experiences in the classroom. Despite some challenges facing our schools, dedicated and professional educators make profound differences each day.

Sincerely,



Patrick Ogden
Interim State Superintendent
of Public Instruction

Funding Sources

Appreciation is expressed for the tremendous educational input and monetary commitment of several organizations for the successful delivery of the Elementary CORE Academy. This year's Elementary CORE Academy was developed and funded through a variety of sources. The Utah State Office of Education (USOE), in collaboration with Utah State University (USU) and local school districts of Utah, have supported kindergarten through sixth grade teachers with professional development experiences that will enhance the educational experience for Utah children.

Major funding for the Academy comes from the following sources:

Federal/State Funds:

Utah State Office of Education
Staff Development Funds
Special Education Services Unit

ESEA Title II

Utah Math Science Partnership

WestED Eisenhower Regional Consortium

District Funds:

Various sources including Quality Teacher Block, Federal ESEA Title II, and District Professional Development Funds

School Funds:

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Utah State Office of Education Special Education Services

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Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups such as the Utah Division of Water Resources, National Energy Foundation, Utah Energy Office, and the Utah Mining Association have assisted in the development and delivery of resources in the Academy.

Most important is the thousands of teachers who take time from their summer to attend these professional development workshops. It is these teachers who make this program possible.

Goals of the Elementary CORE Academy

Overall

The purpose of the Elementary CORE Academy is to create high quality teacher instruction and improve student achievement through the delivery of professional development opportunities and experiences for teachers across Utah.

The Academy will provide elementary teachers in Utah with:

1. Models of exemplary and innovative instructional strategies, tools, and resources to meet newly adopted Core Curriculum standards, objectives, and indicators.
2. Practical models and diverse methods of meeting the learning needs of all children, with instruction implementation aligned to the Core Curriculum.
3. Meaningful opportunities for collaboration, self-reflection, and peer discussion specific to innovative and effective instructional techniques, materials, teaching strategies, and professional practices in order to improve classroom instruction.

Learning a limited set of facts will no longer prepare a student for real experiences encountered in today's world. It is imperative that educators have continued opportunities to obtain instructional skills and strategies that provide methods of meeting the needs of all students. Participants of the Academy experience will be better equipped to meet the challenges faced in today's classrooms.

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Sixth Grade Science and Language Arts Core Curriculum

Utah Elementary Science Core Curriculum

Introduction

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands–on, active experiences throughout the instruction of the science curriculum.

The Elementary Science Core describes what students should know and be able to do at the end of each of the K–6 grade levels. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science, the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

Organization of the Elementary Science Core

The Core is designed to help teachers organize and deliver instruction.

The Science Core Curriculum's organization:

- Each grade level begins with a brief course description.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.

- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

Guidelines Used in Developing the Elementary Science Core

Reflects the Nature of Science

Science is a way of knowing, a process of gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students. Please see the Intended Learning Outcomes document for each grade level core.

As described in these ILOs, students will:

1. Use science process and thinking skills.
2. Manifest science interests and attitudes.
3. Understand important science concepts and principles.
4. Communicate effectively using science language and reasoning.
5. Demonstrate awareness of the social and historical aspects of science.
6. Understand the nature of science.

Coherent

The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

Developmentally Appropriate

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to each grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom), because they repeated appropriate names and vocabulary (such as electron and neutron). The Core resists the temptation to tell about abstract concepts at inappropriate grade levels, but focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Good Teaching Practices

It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Elementary Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students' daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes. The vignettes listed on the "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science for each of the Core standards provide examples, based on actual practice, that demonstrate that excellent teaching of the Science Core is possible.

Comprehensive

The Elementary Science Core does not cover all topics that have traditionally been in the elementary science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Feasible

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with

The Core is:

- **Coherent**
- **Developmentally Appropriate**
- **Encourages Good Teaching Practices**
- **Comprehensive**
- **Feasible**
- **Useful and Relevant**
- **Encourages Good Assessment Practices**

easily obtained resources and materials. A Teacher Resource Book (TRB) is available for elementary grades and has sample lessons on each topic for each grade level. The TRB is a document that will grow as teachers add exemplary lessons aligned with the new Core. The middle grade levels have electronic textbooks available at the Utah State Office of Education's "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science.

Useful and Relevant

This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

Encourages Good Assessment Practices

Student achievement of the standards and objectives in this Core are best assessed using a variety of assessment instruments. One's purpose should be clearly in mind as assessment is planned and implemented. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding of science.

The Most Important Goal

Elementary school reaches the greatest number of students for a longer period of time during the most formative years of the school experience. Effective elementary science instruction engages students actively in enjoyable learning experiences. Science instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or holding a toad. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science–related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of doing science.

Sixth Grade Science Core Curriculum

The theme for Sixth Grade Science is Scale, with Relative Position as an underlying concept. Sixth graders should begin to relate to the incredible size and distance of objects in the solar system, galaxy, and universe, as well as compare their world to the miniscule scale of microorganisms. Students will also understand how relative position affects such events as the appearance of the moon and the changing of the seasons. Students will experiment with heat, light, and sound, and begin to understand concepts of energy.

Students should begin to design and perform experiments and value inquiry as the fundamental scientific process. They should be encouraged to maintain an open and questioning mind as they plan and conduct experiments. They should be helped and encouraged to pose their own questions about objects, events, processes, and results. They should have the opportunity to plan and conduct their own experiments, and come to their own conclusions as they read, observe, compare, describe, infer, and draw conclusions. The results of their experiments need to be compared for reasonableness to multiple sources of information. It is important for students at this age to begin to formalize the processes of science and be able to identify the variables in a formal experiment.

Good science instruction requires hands–on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for all students to experience many things. Sixth graders should experience the excitement of locating the North Star and Little Dipper, and the wonders of gazing into the night sky. They should find the fascination of peering into the world of microorganisms, experimenting and watching them as they move and feed and reproduce. Students should come to enjoy science as a process of discovering the natural world.

Science Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing, and mathematics skills should be emphasized as integral to the instruction of science. Technology issues and the nature of science are significant components of this Core. Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.

This Core was designed using the American Association for the Advancement of Science's Project 2061: Benchmarks For Science

- **Design and perform experiments**
- **Value inquiry**
- **Maintain an open and questioning mind**
- **Pose questions about objects, events, processes, and results**
- **Plan and conduct experiments**
- **Read, observe, compare, describe, infer, and draw conclusions**
- **Formalize the process of science**
- **Identify variables in a formal experiment**

Literacy and the National Academy of Science's National Science Education Standards as guides to determine appropriate content and skills.

The sixth grade Science Core has three online resources designed to help with classroom instruction; they include Teacher Resource Book –a set of lesson plans, assessment items and science information specific to sixth grade; Sci-ber Text –an electronic science textbook specific to the Utah Core; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the sixth grade Science Core. These resources are all available on the Utah Science Home Page at http://www.usoe.k12.ut.us/curr/science .

SAFETY PRECAUTIONS

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Proper handling and disposal of microorganisms is crucial for a safe classroom. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

Intended Learning Outcomes for Sixth Grade Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

By the end of sixth grade students will be able to:

1. **Use Science Process and Thinking Skills**
   a. Observe simple objects, patterns, and events, and report their observations.
   b. Sort and sequence data according to criteria given.
   c. Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
   d. Compare things, processes, and events.
   e. Use classification systems.
   f. Plan and conduct simple experiments.
   g. Formulate simple research questions.
   h. Predict results of investigations based on prior data.
   i. Use data to construct a reasonable conclusion.
2. **Manifest Scientific Attitudes and Interests**
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read and look at books and other materials about science.
   c. Pose science questions about objects, events, and processes.
   d. Maintain an open and questioning mind toward new ideas and alternative points of view.
   e. Seek and weigh evidence before drawing conclusions.
   f. Accept and use scientific evidence to help resolve ecological problems.

- **Use Science Process and Thinking Skills**
- **Manifest Scientific Attitudes and Interests**
- **Understand Science Concepts and Principles**
- **Communicate Effectively Using Science Language and Reasoning**
- **Demonstrate Awareness of Social and Historical Aspects of Science**
- **Understand the Nature of Science**

3. **Understand Science Concepts and Principles**
   a. Know and explain science information specified for the grade level.
   b. Distinguish between examples and non-examples of concepts that have been taught.
   c. Solve problems appropriate to grade level by applying science principles and procedures.
4. **Communicate Effectively Using Science Language and Reasoning**
   a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
   b. Describe or explain observations carefully and report with pictures, sentences, and models.
   c. Use scientific language in oral and written communication.
   d. Use reference sources to obtain information and cite the source.
   e. Use mathematical reasoning to communicate information.
5. **Demonstrate Awareness of Social and Historical Aspects of Science**
   a. Cite examples of how science affects life.
   b. Understand the cumulative nature of science knowledge.
6. **Understand the Nature of Science**
   a. Science is a way of knowing that is used by many people not just scientists.
   b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
   c. Science findings are based upon evidence.

Sixth Grade Science Standards

Science Benchmark

The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the sun. Earth turns on an axis that is tilted relative to the plane of Earth's yearly orbit. The tilt causes sunlight to fall more intensely on different parts of the Earth during various parts of the year. The differences in heating of Earth's surface and length of daylight hours produce the seasons.

Standard I: **Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.**

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.

b. Identify the pattern of change in the moon's appearance.

c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.

d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

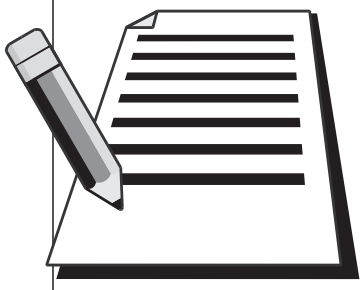
Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.

b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.

c. Model the movement and relative positions of Earth, the moon, and the sun.

Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.



Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Standard II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1: Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

a. Describe the yearly revolution (orbit) of Earth around the sun.

b. Explain that Earth's axis is tilted relative to its yearly orbit around the sun.

c. Investigate the relationship between the amount of heat absorbed and the angle to the light source.

Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

a. Compare Earth's position in relationship to the sun during each season.

b. Compare the hours of daylight and illustrate the angle that the sun's rays strikes the surface of Earth during summer, fall, winter, and spring in the Northern Hemisphere.

c. Use collected data to compare patterns relating to seasonal daylight changes.

d. Use a drawing and/or model to explain that changes in the angle at which light from the sun strikes Earth, and the length of daylight, determine seasonal differences in the amount of energy received.

e. Use a model to explain why the seasons are reversed in the Northern and Southern Hemispheres.

Science language students should use:
Earth's tilt, seasons, axis of rotation, orbits, phases of the moon, revolution, reflection

Science Benchmark

The solar system consists of planets, moons, and other smaller objects including asteroids and comets that orbit the sun. Planets in the solar system differ in terms of their distance from the sun, number of moons, size, composition, and ability to sustain life. Every object exerts gravitational force on every other object depending on the mass of the objects and the distance between them. The sun's gravitational pull holds Earth and other planets in orbit. Earth's gravitational force holds the moon in orbit. The sun is one of billions of stars in the Milky Way galaxy, that is one of billions of galaxies in the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard III: **Students will understand the relationship and attributes of objects in the solar system.**

Objective 1: Describe and compare the components of the solar system.

a. Identify the planets in the solar system by name and relative location from the sun.

b. Using references, compare the physical properties of the planets (e.g., size, solid or gaseous).

c. Use models and graphs that accurately depict scale to compare the size and distance between objects in the solar system.

d. Describe the characteristics of comets, asteroids, and meteors.

e. Research and report on the use of manmade satellites orbiting Earth and various planets.

Objective 2: Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

a. Describe the use of instruments to observe and explore the moon and planets.

b. Describe the role of computers in understanding the solar system (e.g., collecting and interpreting data from observations, predicting motion of objects, operating space probes).

c. Relate science's understanding of the solar system to the technology used to investigate it.

d. Find and report on ways technology has been and is being used to investigate the solar system.

Standard III:
Students will understand the relationship and attributes of objects in the solar system.

Objective 3: Describe the forces that keep objects in orbit in the solar system.

a. Describe the forces holding Earth in orbit around the sun, and the moon in orbit around Earth.

b. Relate a celestial object's mass to its gravitational force on other objects.

c. Identify the role gravity plays in the structure of the solar system.

Standard IV: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

a. Use the speed of light as a measuring standard to describe the relative distances to objects in the universe (e.g., 4.4 light years to star Alpha Centauri; 0.00002 light years to the sun).

b. Compare distances between objects in the solar system.

c. Compare the size of the Solar System to the size of the Milky Way galaxy.

d. Compare the size of the Milky Way galaxy to the size of the known universe.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

a. Locate and identify stars that are grouped in patterns in the night sky.

b. Identify ways people have historically grouped stars in the night sky.

c. Recognize that stars in a constellation are not all the same distance from Earth.

d. Relate the seasonal change in the appearance of the night sky to Earth's position.

e. Describe ways that familiar groups of stars may be used for navigation and calendars.

Science language students should use:
asteroids, celestial object, comets, galaxy, planets, satellites, star, distance, force, gravity, gravitational force, mass, scale, solar system, constellation, Milky Way galaxy, speed of light, telescope, universe, sun, light years

Standard IV:
Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Science Benchmark

Microorganisms are those living things that are visible as individual organisms only with the aid of magnification. Microorganisms are components of every ecosystem on Earth. Microorganisms range in complexity from single to multicellular organisms. Most microorganisms do not cause disease and many are beneficial. Microorganisms require food, water, air, ways to dispose of waste, and an environment in which they can live. Investigation of microorganisms is accomplished by observing organisms using direct observation with the aid of magnification, observation of colonies of these organisms and their waste, and observation of microorganisms' effects on an environment and other organisms.

Standard V:
Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Standard V: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 1: Observe and summarize information about microorganisms.

a. Examine and illustrate size, shape, and structure of organisms found in an environment such as pond water.

b. Compare characteristics common in observed organisms (e.g., color, movement, appendages, shape) and infer their function (e.g., green color found in organisms that are producers, appendages help movement).

c. Research and report on a microorganism's requirements (i.e., food, water, air, waste disposal, temperature of environment, reproduction).

Objective 2: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

a. Formulate a question about microorganisms that can be answered with a student experiment.

b. Develop a hypothesis for a question about microorganisms based on observations and prior knowledge.

c. Plan and carry out an investigation on microorganisms. {Note: Teacher must examine plans and procedures to assure the safety of students; for additional information, you may wish to read microbe safety information on Utah Science Home Page.}

d. Display results in an appropriate format (e.g., graphs, tables, diagrams).

e. Prepare a written summary or conclusion to describe the results in terms of the hypothesis for the investigation on microorganisms.

Objective 3: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.

b. Identify how microorganisms are used as food or in the production of food (e.g., yeast helps bread rise, fungi flavor cheese, algae are used in ice cream, bacteria are used to make cheese and yogurt).

c. Identify helpful uses of microorganisms (e.g., clean up oil spills, purify water, digest food in digestive tract, antibiotics) and the role of science in the development of understanding that led to positive uses (i.e., Pasteur established the existence, growth, and control of bacteria; Fleming isolated and developed penicillin).

d. Relate several diseases caused by microorganisms to the organism causing the disease (e.g., athlete's foot -fungi, streptococcus throat -bacteria, giardia -protozoa).

e. Observe and report on microorganisms' harmful effects on food (e.g., causes fruits and vegetables to rot, destroys food bearing plants, makes milk sour).

Science language students should use:
algae, fungi, microorganism, decomposer, single–celled, organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Science Benchmark

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard VI: Students will understand properties and behavior of heat, light, and sound.

Standard VI: Students will understand properties and behavior of heat, light, and sound.

Objective 1: Investigate the movement of heat between objects by conduction, convection, and radiation.

a. Compare materials that conduct heat to materials that insulate the transfer of heat energy.

b. Describe the movement of heat from warmer objects to cooler objects by conduction and convection.

c. Describe the movement of heat across space from the sun to Earth by radiation.

d. Observe and describe, with the use of models, heat energy being transferred through a fluid medium (liquid and/or gas) by convection currents.

e. Design and conduct an investigation on the movement of heat energy.

Objective 2: Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

a. Compare light from various sources (e.g., intensity, direction, color).

b. Compare the reflection of light from various surfaces (e.g., loss of light, angle of reflection, reflected color).

c. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).

d. Predict and test the behavior of light interacting with various fluids (e.g., light transmission through fluids, refraction of light).

e. Predict and test the appearance of various materials when light of different colors is shone on the material.

Objective 3: Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

a. Describe how sound is made from vibration and moves in all directions from the source in waves.

b. Explain the relationship of the size and shape of a vibrating object to the pitch of the sound produced.

c. Relate the volume of a sound to the amount of energy used to create the vibration of the object producing the sound.

d. Make a musical instrument and report on how it produces sound.

Science language students should use:
angle of incidence, angle of reflection, absorption, conduction, conductor, convection, medium, pitch, prism, radiation, reflection, refraction, spectrum, vibration

Sixth Grade Language Arts Standards

Standard I: ***Oral Language*—Students develop language for the purpose of effectively communicating through listening, speaking, viewing, and presenting.**

Objective 1: Develop language through listening and speaking.

a. Identify specific purpose(s) for listening (e.g., to gain information, to be entertained).

b. Listen and demonstrate understanding by responding appropriately (e.g., follow multiple-step directions, restate, clarify, question, summarize, elaborate formulating an opinion with supporting evidence, interpret verbal and nonverbal messages, note purpose and perspective, identify tone, mood, emotion).

c. Speak clearly and audibly with expression in communicating ideas (i.e., effective rate, volume, pitch, tone, phrasing, tempo).

d. Speak using complex sentences with appropriate subject-verb agreement, correct verb tense, and syntax.

Objective 2: Develop language through viewing media and presenting.

a. Identify specific purpose(s) for viewing media (i.e., to identify main idea and details, to gain information, distinguish between fiction/nonfiction, distinguish between fact/opinion, form an opinion, determine presentation's accuracy/bias, analyze and critique persuasive techniques).

b. Use a variety of formats in presenting with various forms of media (e.g., pictures, posters, charts, ads, newspapers, graphs, videos, slide shows).

Standard I:
***Oral Language*—Students develop language for the purpose of effectively communicating through listening, speaking, viewing, and presenting.**

Standard II: ***Concepts of Print*—Students develop an understanding of how printed language works.**

Objective 1: Demonstrate an understanding that print carries "the" message.

a. Recognize that print carries different messages.

b. Identify messages in common environmental print (e.g., signs, boxes, wrappers).

Objective 2: Demonstrate knowledge of elements of print within a text.

a. Identify front/back, top/bottom, left/right of text/book.

b. Discriminate between upper- and lower-case letters, numbers, and words in text.

c. Show the sequence of print by pointing left to right with return sweep.

d. Identify where text begins and ends on a page.

e. Identify punctuation in text (i.e., periods, question marks, exclamation points).

Standard II: ***Concepts of Print*—Students develop an understanding of how printed language works.**

Standard III: ***Phonological and Phonemic Awareness*—Students develop phonological and phonemic awareness.**

Objective 1: Demonstrate phonological awareness.

a. Count the number of words in a sentence.

b. Identify and create a series of rhyming words orally (e.g., cat, bat, sat, _____).

c. Recognize words beginning with the same initial sound in an alliterative phrase or sentence (e.g., Six snakes sold snacks and sodas.).

Objective 2: Recognize like and unlike word parts (oddity tasks).

a. Identify the word that does not rhyme in a series of words (e.g., bat, cat, sat, pig).

b. Identify the words with same beginning consonant sound in a series of words (e.g., man, sat, sick) and ending consonant sound (e.g., man, sat, then).

Objective 3: Orally blend word parts (blending).

a. Blend syllables to make words (e.g., /ta/.../ble/, table).

b. Blend onset and rimes to make words (e.g., /p/…/an/, pan).

c. Blend individual phonemes to make words (e.g., /s/…/a/…/t/, sat).

Objective 4: Orally segment words into word parts (segmenting).

a. Segment words into syllables (e.g., table, /ta/…/ble/).

b. Segment words into onset and rime (e.g., pan, /p/…an).

c. Segment words into individual phonemes (e.g., sat, /s/…/a/…/t/).

Objective 5: Orally manipulate phonemes in words and syllables (manipulation).

a. Substitute initial sound (e.g., replace the first sound in mat to /s/, say sat).

b. Substitute initial sound to create new words (e.g., replace the first sound in mat with letters of the alphabet).

Standard III: ***Phonological and Phonemic Awareness*— Students develop phonological and phonemic awareness.**

Standard IV: ***Phonics and Spelling*—Students use phonics and other strategies to decode and spell unfamiliar words while reading and writing.**

Objective 1: Demonstrate an understanding of the relationship between letters and sounds.

a. Name all upper-and lower-case letters of the alphabet in random order.

b. Match consonant and short vowel sounds to the correct letter.

c. Blend simple cvc sounds into one-syllable words.

Standard IV: ***Phonics and Spelling*—Students use phonics and other strategies to decode and spell unfamiliar words while reading and writing.**

Objective 2: Use knowledge of structural analysis to decode words.

a. Identify and read grade level contractions and compound words.

b. Identify sound patterns and apply knowledge to decode words (e.g., blends, digraphs, vowel patterns, r-controlled vowels).

c. Demonstrate an understanding of representing the same sound with different patterns by decoding these patterns accurately in isolation and in text (e.g., ee, ea, ei, e).

d. Use knowledge of root words and prefixes (e.g., re, un, mis) and suffixes (e.g., s, es, ed, ing, est, ly) to decode words.

e. Use letter and syllable patterns to pronounce multisyllabic words.

Objective 3: Spell words correctly.

a. Use knowledge of word families, patterns, syllabication, and common letter combinations to spell new words.

b. Use knowledge of Greek and Latin roots and affixes to spell multisyllable words.

c. Spell an increasing number of high-frequency and irregular words correctly (e.g., straight, soldier, property, particular).

d. Learn the spellings of irregular and difficult words (e.g., feudalism, electricity, parallelogram, microorganism).

Objective 4: Use spelling strategies to achieve accuracy (e.g., prediction, visualization, association).

a. Use knowledge about spelling to predict the spelling of new words.

b. Visualize words while writing.

c. Associate spelling of new words with that of known words and word patterns.

d. Use spelling generalities to assist spelling of new words.

Standard V: ***Fluency*—Students develop reading fluency to read aloud grade level text effortlessly without hesitation.**

Objective 1: Read aloud grade level text with appropriate speed and accuracy.

a. Read grade level text at a rate of approximately 120-150 wpm.

b. Read grade level text with an accuracy rate of 95-100%.

Objective 2: Read aloud grade level text effortlessly with clarity.

a. Read grade level text in meaningful phrases using intonation, expression, and punctuation cues.

b. Read grade level words with automaticity.

Standard V: ***Fluency*—Students develop reading fluency to read aloud grade level text effortlessly without hesitation.**

Standard VI: ***Vocabulary*—Students learn and use grade level vocabulary to increase understanding and read fluently.**

Objective 1: Learn new words through listening and reading widely.

a. Use new vocabulary learned by listening, reading, and discussing a variety of genres.

b. Learn the meaning and properly use a variety of grade level words (e.g., words from literature, social studies, science, math).

Standard VI: ***Vocabulary*— Students learn and use grade level vocabulary to increase understanding and read fluently.**

Objective 2: Use resources to learn new words by relating them to known words and/or concepts.

a. Use multiple resources to determine the meanings of unknown words (e.g., dictionaries, glossaries, thesauruses).

b. Determine gradients of meanings between related words and concepts (e.g., colonization: exploration, migrate, settlement).

Objective 3: Use structural analysis and context clues to determine meanings of words.

a. Identify meanings of words using roots and affixes (i.e., Greek/Latin affixes).

b. Use words, sentences, and paragraphs as context clues to determine meanings of unknown key words, similes, metaphors, idioms, proverbs, clichés, and literary expressions.

c. Use context to determine meanings of synonyms, antonyms, homonyms (e.g., through/threw, principal, principle) and multiple-meaning words (e.g., print).

Standard VII: ***Comprehension*—Students understand, interpret, and analyze narrative and informational grade level text.**

Objective 1: Identify purposes of text.

a. Identify purpose for reading.

b. Identify author's purpose.

Objective 2: Apply strategies to comprehend text.

a. Relate prior knowledge to make connections to text (e.g., text to text, text to self, text to world).

b. Generate questions about text (e.g., factual, inferential, evaluative).

c. Form mental pictures to aid understanding of text.

d. Make and confirm or revise predictions while reading using title, picture clues, text, and/or prior knowledge.

e. Make inferences and draw conclusions from text.

f. Identify theme/topic/main idea from text; note details.

g. Summarize important ideas/events; summarize supporting details in sequence.

h. Monitor and clarify understanding applying fix-up strategies while interacting with text.

i. Compile, organize, and interpret information from text.

Objective 3: Recognize and use features of narrative and informational text.

a. Identify characters, setting, sequence of events, problem/resolution, theme.

b. Compare and contrast elements of different genres: fairy tales, poems, realistic fiction, fantasy, fables, folk tales, tall tales, biographies, historical fiction, science fiction, myths, legends.

c. Identify information from text, headings, subheadings, diagrams, charts, captions, graphs, table of contents, index, and glossary.

d. Identify different structures in text (e.g., description, problem/solution, compare/contrast, cause/effect, order of importance, time, geographic classification).

e. Locate facts from a variety of informational texts (e.g., newspapers, magazines, textbooks, biographies, Internet, other resources).

Standard VII: ***Comprehension*—Students understand, interpret, and analyze narrative and informational grade level text.**

Standard VIII: ***Writing*—Students write daily to communicate effectively for a variety of purposes and audiences.**

Objective 1: Prepare to write by gathering and organizing information and ideas (prewriting).

a. Generate ideas for writing by reading, discussing, researching, and reflecting on personal experiences.

b. Select and narrow a topic from generated ideas.

c. Identify audience, purpose, and form for writing.

d. Use a variety of graphic organizers to organize information from multiple sources.

Standard VIII: ***Writing*—Students write daily to communicate effectively for a variety of purposes and audiences.**

Objective 2: Compose a written draft.

a. Draft ideas on paper in an organized manner utilizing words, sentences, and multiple paragraphs (e.g., beginning, middle, end; main idea; details; characterization; setting; plot).

b. Use voice to fit the purpose and audience.

c. Use strong verbs and precise and vivid language to convey meaning.

d. Identify and use effective leads and strong endings.

Objective 3: Revise by elaborating and clarifying a written draft.

a. Revise draft to add details, strengthen word choice, clarify main idea, and reorder content.

b. Enhance fluency by using transitional words, phrases to connect ideas, and a variety of complete sentences and paragraphs to build ideas (e.g., varied sentence length, simple and compound sentences).

c. Revise writing, considering the suggestions from others.

Objective 4: Edit written draft for conventions.

a. Edit writing for correct capitalization and punctuation (i.e., introductory and dependent clauses, dialogue, singular and plural possessives).

b. Edit for spelling of grade level-appropriate words.

c. Edit for standard grammar (e.g., subject-verb agreement, verb tense, irregular verbs).

d. Edit for appropriate formatting features (e.g., margins, indentations, titles, headings).

Objective 5: Use fluent and legible handwriting to communicate.

a. Write using upper- and lower-case cursive letters using proper from, proportions, and spacing.

b. Increase fluency with cursive handwriting.

c. Produce legible documents with manuscript or cursive handwriting.

Objective 6: Write in different forms and genres.

a. Produce personal writing (e.g., journals, personal experiences, eyewitness accounts, memoirs, literature responses).

b. Produce traditional and imaginative stories, narrative and formula poetry.

c. Produce informational text (e.g., book reports, cause/effect reports, compare/contrast essays, observational/research reports, content area reports, biographies, historical fiction, summaries).

d. Produce writing to persuade (e.g., essays, editorials, speeches, TV scripts, responses to various media).

e. Produce functional texts (e.g., newspaper and newsletters articles, e-mails, simple PowerPoint presentations, memos, agendas, bulletins, web pages).

f. Share writing with others incorporating relevant illustrations, photos, charts, diagrams, and/or graphs to add meaning.

g. Publish 6-8 individual products.

Facilitated Activities

Design An Experiment: Goldilocks and the Three Bowls

A first grade teacher has asked for help in solving a debate her students are having. They just read *Goldilocks and the Three Bears*, but they do not think it is very accurate in that the mother's bowl of porridge got cold first. They want to know if you can help solve the debate scientifically.

……

From: Mr./Mrs. _____'s First Grade Class

To: Mr./Mrs. _____'s Sixth Grade Science Class

Dear Students,

Our first grade class recently read *Goldilocks and the Three Bears*. Why did Mama Bear's porridge got cold the fastest? As you remember, Goldilocks didn't like the big bowl of porridge (Papa's) because it was too hot. She also didn't like the middle-sized bowl of porridge (Mama's) because it was too cold. She finally tried the smallest bowl of porridge and said it was just right. Something about the temperature of the porridge just doesn't seem right to me. I am very concerned that I teach my students information that is scientifically accurate. Can your class help me out with this perplexing question?

Thank you,

……

Procedures

1. **On journal paper**, design a test for the porridge. List each step you will follow. Materials will include: three bowls, three thermometers, porridge, measuring cups, rubber scrapers, safety goggles.
   a. How will you make it a fair test? What will be your variables? Your control?
   b. How much porridge will you put in each bowl?
   c. Where will you put the thermometer? (side, middle, bottom)
   d. How long will you wait after putting the thermometer in the porridge before taking the beginning temperature?
   e. Who will record time?
   f. What is the very best and most accurate way of doing this activity?
   g. Which bowl of porridge do you predict will be the coolest after 12 minutes? Why?
2. **Your teacher will help you get the porridge AFTER you have designed your experiment.**

Background information for teacher:

- ❑ Use this activity after students have:
  a. studied thermometers
  b. practiced making data charts
  c. have studied controlled experiments, variables, and controls (constants). Multiple variables are used. (e.g., amount of porridge, size of bowl, etc.)
- ❑ Review *Goldilocks and the Three Bears*.
- ❑ Quick Quaker Oats works well for the porridge. Use a hot plate and a pot. Extra water will keep it from sticking and burning. The porridge can be recycled for multiple classes by scraping it back into the pot after each class. Use a wooden spoon for stirring and a measuring cup for dipping out portions.

3. Use the data chart shown below or construct your own.

	Beginning temperature of porridge	Temperature after three minutes	Temperature after six minutes	Temperature after nine minutes	Temperature after 12 minutes
Papa's Bowl					
Mama's Bowl					
Baby Bear's Bowl					

4. Use the conclusions from your data chart to answer the following questions.
   a. Which bowl of porridge cooled off the most by the end of the activity?
   b. Is this what you thought would happen?
   c. Now for the important question: What does this mean in terms of heat?

5. Write a letter to the first grade class explaining what you found out and what you think this means for *Goldilocks and the Three Bears*. Make it a fun and interesting letter for them.

   Your letter should include the following:

   - Neat printing that first graders can read.
   - Words that first graders can decode and understand.
   - Explanation of the experiment—what was tested?
   - Conclusion/results—what was discovered?
   - Date and greeting (Dear, Hello, Hi).
   - Indented paragraphs with complete sentences.
   - Closing (Sincerely, Yours truly, Thanks).
   - Your name.

6. Have Fun!

Name _____

Design An Experiment: Goldilocks and the Three Bowls

From: Mr./Mrs. _____'s First Grade Class

To: Mr./Mrs. _____'s Sixth Grade Science Class

Dear Students,

Our first grade class recently read *Goldilocks and the Three Bears*. Why did Mama Bear's porridge got cold the fastest? As you remember, Goldilocks didn't like the big bowl of porridge (Papa's) because it was too hot. She also didn't like the middle-sized bowl of porridge (Mama's) because it was too cold. She finally tried the smallest bowl of porridge and said it was just right. Something about the temperature of the porridge just doesn't seem right to me. I am very concerned that I teach my students information that is scientifically accurate. Can your class help me out with this perplexing question?

Thank you,

Procedures

1. **On journal paper**, design a test for the porridge. List each step you will follow. Materials will include: three bowls, three thermometers, porridge, measuring cups, rubber scrapers, safety goggles.
   a. How will you make it a fair test? What will be your variables? Your control?
   b. How much porridge will you put in each bowl?
   c. Where will you put the thermometer? (side, middle, bottom)
   d. How long will you wait after putting the thermometer in the porridge before taking the beginning temperature?
   e. Who will record time?
   f. What is the very best and most accurate way of doing this activity?
   g. Which bowl of porridge do you predict will be the coolest after 12 minutes? Why?
2. **Your teacher will help you get the porridge AFTER you have designed your experiment.**

3. Use the data chart shown below or construct your own.

	Beginning temperature of porridge	Temperature after three minutes	Temperature after six minutes	Temperature after nine minutes	Temperature after 12 minutes
Papa's Bowl					
Mama's Bowl					
Baby Bear's Bowl					

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   - Date and greeting (Dear, Hello, Hi).
   - Indented paragraphs with complete sentences.
   - Closing (Sincerely, Yours truly, Thanks).
   - Your name.

6. Have Fun!

Helpful Hints for Supporting All Learners

The following information is provided as a resource for teachers as they work with the diverse learners they encounter in their classrooms. Most ideas presented are for use in any content area and at any grade level, including the K-2 Content, Math, and Science Core curricula that are the focus of the 2004 Elementary CORE Academy.

Common barriers to learning and ways to overcome those barriers are presented, as well as the basic fundamentals of differentiating instruction. Also included is a checklist for highlighting appropriate student-specific adaptations and modifications designed to help struggling students, including the gifted.

There is also a chart that describes weaknesses in cognitive processes that could explain why a student struggles with particular reading or other academic skills. This information should be provided through formalized assessment.

For more information, please contact curriculum or special education specialists at the Utah State Office of Education or the specialists at the Utah Personnel Development Center.

- **Barriers Students Face**
- **Engaging All Learners**
- **Adaptation/ Modification Checklist**
- **Why Students Struggle in the Classroom**

Barriers Students Face

1. Barriers exist that encumber the path to academic achievement for students.
2. The way to get around the barriers is by employing effective instructional practices that utilize differentiation strategies.
3. Two elements of a learning setting can be points of differentiation.
   a. Person—learner
      These characteristics are out of the control of the teacher, but can be positively influenced by differentiation.
      - *Learning Preference* (style or strength)
      - *Learning Ability* (enhanced or impaired)

   b. Process—instruction
      These practices during the instructional cycle are within the control of the teacher and can positively influence student achievement.
      - *Input* (instructional delivery)
      - *Output* (demonstration of learning)

Common Barriers

PERSON—Student	What to do about it	PROCESS—Instruction	What to do about it
Limited language skills	Pre-teach critical or potentially troublesome vocabulary. Provide visual or kinesthetic cues.	**Unclear directions and expectations**	Reduce instructional clutter. Provide simple clear directions. Teach and maintain consistent routines.
Trouble maintaining attention	Provide short, intense learning sessions, vary tasks, break down complex tasks.	**Over-reliance on worksheets/bookwork**	Provide explicit instruction, examples, and relevant practice. Provide adequate guided practice.
Inadequate mastery of prerequisite skills	Provide experience or background knowledge Do not assume anything.	**Inadequate Guided Practice during lesson sequence**	Continue with guided practice until 90% of your students are performing skill at 80%-90% or better.
Inefficient processing skills	Allow think time, provide physical cue to respond, rehearse responses, use simple vocabulary, check for understanding, give one direction at a time, wait time.	**Use of abstract examples**	Use clear, easily recognizable examples during initial phases of instruction. Use visual, auditory, and kinesthetic representations. Relate to real-life.
Impaired academic learning ability	Make tasks less complex, reduce amount of content to be leaned, relate to real-life experience of student.	**Only one option for students to demonstrate learning**	Provide more than one way for students to show what they know. Same criteria, demonstration is different.
Advanced academic learning ability	Make tasks more complex. Increase amount of content to be learned.	**Inappropriate use of homework**	Homework is review, not new learning. Do not use as busy work. Provide feedback.

Engaging All Learners

Hints for Differentiating Instruction

1. **INPUT—instruction**

   Visual Learners—use pictures, videos, diagrams, maps, guided notes, flow charts, demonstration, flash cards, study cards

   Auditory Learners—use lecture, telling, discussion, audio tracks, read aloud, debate, listen to news reports

   Kinesthetic Learners—use underlining, manipulatives, tracing, highlighting, dramatize, pantomime, mimic actions, field trips, information walks, actions, sign language.

2. **OUTPUT—demonstration of learning**

   Visual Learners—allow collages, drawings, diagrams, symbols, posters, cartoons, photos, maps, flow-charts, video

   Auditory Learners—allow storytelling, debates, speech, song/rap, interview, newspaper article, discussion, essays, journaling

   Kinesthetic Learners—allow painting, dancing, molding, model building, role play, pantomimes, games, creations, raps

Hints for Extending Instruction: for Academically Advanced Students

1. **INPUT—instruction**

   More Content—more elements to master, more independent study, supplementary materials, use less obvious examples, give more abstract examples and ideas, less practice on material given

   More Complex Task—more responses, more complex directions, more examples, more opportunities to generalize, less teacher direction

2. **OUTPUT—demonstration of learning**

   More Content—more concepts to demonstrate, require broad generalization, group work, complex assignments, generation instead of recognition, proficiency on more skills

   More Complex Task—require more responses, increase number of examples demonstrated, student must reorganize information, student develops more strategies for remembering—shares with others, teaches others

Hints for Accommodating Instruction: for Academically Struggling Students (Spec. Ed, 504, ELL, other)

Changes HOW student accesses or demonstrates learning.

NO change in HOW MUCH learning is expected.

1. **INPUT—instruction**

   Math—provide photocopy of assignment to write on, break down complex tasks, allow calculator use, use fact charts, give prompts for remembering steps, "think" out loud when instructing, increase amount of guided practice, teach strategies, identify and teach critical elements, peer partners, relate to real-life, guided notes

   Science—provide text reader, graphic organizers, teach prerequisite vocabulary, read written directions aloud, provide guided notes, explanations, clear examples and non examples, identify and teach critical elements, cloze procedure note taking, experiential activities, chunk instructional periods, multi-sensory approach, break-down complex tasks, relate to real-life, teach memory strategies

2. **OUTPUT—demonstration of learning**

   Math—allow extra time, partial assignments, use calculator, give prompts for formula steps, use a "do/redo/turn-in" option, do not mix examples and non-examples without clear warning, photocopy of assignment to write answers on, a copy of book for home, mix current lesson with basic skill review problems, check for understanding, homework partner, accept work done in class

   Science—allow verbal responses, posters, models, reduce choices on matching, give more time, short answer instead of essay, type instead of write, proofreader, do not penalize for spelling errors, demonstrations, provide a task analysis or completion checklist, review needed materials or steps, reduce writing load on assignments, allow a "do/re-do" option

Hints for Modifying Instruction for students with disabilities (Spec. Ed-must have an IEP)

Changes in WHAT/HOW MUCH a student is expected to learn.

1. **INPUT—instruction**

   Less Content—instruct on one or two basic skills/ideas, parallel curriculum on same topic, use simple real-life examples, simplify guided notes, provide concept summaries with easy to understand words, provide more practice with less material, use more examples with less material, reduce content clutter in lessons

   Less Complex Task—use words with literal meanings, break tasks down then teach each part to mastery, provide more prompts during guided practice, highlight basic information, keep tasks to one to three steps, provide guidance for remembering/associating information, provide easy diagrams or templates

2. OUTPUT—demonstration of learning

Less Content—fewer elements to master, one or two concepts to demonstrate, reduce assignment length, relate assignment to functional/real-life skills, assign easiest job during group work, have students recognize instead of generate information, require proficiency on only one or two skills

Less Complex Task—break down task, require only one or two responses, limit choices on matching, provide high level of prompting, outline necessary steps, allow strategies for remembering, give fewer practice exercises, reduce number of test items, give a modified test, highlight basic information, allow student to point to or say instead of write out, give extra time

Adaptation/Modification Checklist

Student: _____ Teacher: _____

Testing Adaptations:	**Presentation of Subject Matter:**	**Assignment Accommodations:**
❑ Change essay questions to multiple choice. ❑ Reduce multiple choice to _____ choices. ❑ Avoid True or False questions. ❑ Avoid essay questions. ❑ Provide a word bank. ❑ Accept short answers. ❑ Give open book/notes tests. ❑ Allow student to record or dictate answers. ❑ Reduce spelling list for spelling tests. ❑ Extend time frame or shorten length of test. ❑ Avoid Scantron answer sheets. ❑ Read test to student. ❑ Provide study guide prior to test. ❑ Type tests and/or use large print. ❑ Test smaller units of material. ❑ Highlight key directions. ❑ Give test in an alternate site. ❑ Allow student to use calculator. ❑ Allow a test retake. ❑ Other: _____.	❑ Teach to the student's learning style: _____ ❑ Read text aloud. ❑ Provide small group instruction. ❑ Provide an accurate copy of notes or key points written on the board or overhead. ❑ Model lesson being taught. ❑ Utilize manipulatives. ❑ Highlight critical information. ❑ Pre-teach the vocabulary. ❑ Do not call on the student to read aloud in class. ❑ Check student's understanding during the lesson. ❑ Provide study guides. ❑ Assign a study buddy. ❑ Allow time for student to process directions/information. ❑ Other: _____.	❑ Give directions in writing and verbally. ❑ Avoid penalizing for spelling errors, except on spelling tests/assignments. ❑ Show an example of what the completed assignment should look like. ❑ Reduce assignment. ❑ Read written work to student. ❑ Provide alternate assignment/strategy when demands of assignment conflict with student capabilities. ❑ Allow student to word process assignment. ❑ Avoid penalizing for poor penmanship. ❑ Allow student to use manuscript. ❑ Communicate homework expectations with parents. ❑ Check for student's understanding of the task. ❑ Chunk tasks. ❑ Allow a scribe or note taker. ❑ Other: _____.
Materials:	**Grading:**	**Miscellaneous:**
❑ Taped textbooks or other class material. ❑ Highlighted textbooks. ❑ Special equipment: calculator, computer, word processor/spell checker, other _____ ❑ Large print books. ❑ Special paper (wide-lined, graph, etc.) ❑ Two sets of books; second one for home. ❑ Assignment sheet or planner. ❑ Behavior monitoring sheet. ❑ Other: _____	❑ Use pass/fail grading system. ❑ Use a modified scale. ❑ Give credit for partial completion. ❑ Consider effort in assigning grade. ❑ Give credit for participation. ❑ Give copies of midterms to parents. ❑ Notify special education teacher when grades drop below a C-. ❑ Other: _____	❑ Avoid timed activities. ❑ Implement preferential seating. ❑ Provide cues for staying on task. ❑ Provide a quiet place to work. ❑ Allow short breaks during assignments. ❑ Seat student next to a good role model. ❑ Provide daily check-in time with teacher. ❑ Consider Assistive Technology and Services. ❑ Other: _____.

Why Do Some Students Struggle in Your Classroom?

In explaining deficits in learning, there are weaknesses in cognitive processes that should be ruled in or ruled out through formalized assessment.

Cognitive Processes:	What it looks like in the classroom:
Auditory Processing—Perception, analysis, and synthesis of auditory stimuli.	❑ Confuses words and phrases that sound alike (e.g., "blue" with "blow" or "ball" with "bell"). ❑ Finds it hard to pick out an auditory figure from its background and it may seem that they are not listening or paying attention. ❑ Processes sound slowly and cannot keep up with the flow of conversation, inside or outside the classroom. ❑ Difficulty with phonics (decoding), spelling, and reading fluency.
Visual Perception—Recognizing the position and shape of what is seen (The "Mind's Eye").	❑ Reverses/rotates letters, jumps over words, reads the same line twice, or skip lines. ❑ Difficulty distinguishing a significant form from its background.
Short-Term Memory—Ability to hold information in immediate awareness and use it within a few seconds.	❑ Difficulty learning from lecture, listening and following directions. ❑ Cannot remember information long enough to process for comprehension and retrieval.
Long-Term Retrieval—Ability to store information and retrieve it later over extended time periods.	❑ "I know it but I can't think of it" phenomena. ❑ Demonstrate mastery of information one day and unable to recall it on test day (poor test performance/inconsistent grades).
Comprehension-Knowledge—Breadth and depth of acquired cultural knowledge and experience.	❑ Low vocabulary and reading comprehension. ❑ Difficulty in listening comprehension and in answering factual questions.
Processing Speed—Fluent performance of cognitive tasks automatically when under pressure to maintain attention.	❑ Can't process symbols fast enough to enhance decoding or comprehension. ❑ Does poorly on timed tasks.
Visual-Spatial Thinking—Perception, analysis, synthesis, and manipulation of visual stimuli.	❑ Weakness: rapid sound/symbol associations, copying tasks, and recognizing whole words.
Fluid Reasoning—Involves inductive and deductive reasoning, identifying relations, and drawing inferences.	❑ Difficulty in transfer and generalization. ❑ Poor flexibility in thinking. ❑ Low abstract problem solving.
Attention/Concentration—Ability to filter and prioritize external/internal stimuli to attend.	❑ Poor task/work completion. ❑ Assignments are partially completed, often items are skipped. ❑ Seems disorganized during instruction and practice.
Working Memory—Ability to temporarily store and perform a cognitive operation on a set of information.	❑ Problems with sequencing. ❑ Not flexible in use of strategies to solve problem/task. ❑ Attempts task but only understands a part of it. ❑ Seems unmotivated.
Cognitive Academic Language Proficiency—Proficiency in academic situations and those aspects of language that emerge from formal schooling.	❑ Understands more than can express. ❑ Difficulty in receptive and expressive language. ❑ Language "different" rather than language "disability". ❑ Poor vocabulary knowledge.

Mather, Nancy, Wendling, Barbara J., & Woodcock, Richard W. Essentials of WJ III Tests of Achievement Assessment. John Wiley & Sons, Inc. New York, 2001, pp. 111-112

Put Reading First: The Research Building Blocks of Reading Instruction, Second Edition, June 2003 [On-Line, PDF] http://www.nifl.gov/partnershipforreading/publications/k-3.html, page 2

Reading Fluency, Mather, N., & Goldstein, S. (2001). [On-Line] http://www.ldonline.org/ld_indepth/reading/reading_fluency.html

Silver, Larry B., M.D. A Look at Learning Disabilities in Children and Youth, [On-Line] http://www.ldonline.org/ld_indepth/reading/reading-2.html

Writing in Science Activities

Introducing Text Structures in Science Writing

Language Arts Standard VII:
Comprehension—Students understand, interpret, and analyze narrative and informational grade level text.

Objective 3:
Recognize and use features of informational text.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Language Arts Standard VII

Objective 3

Connections

Background Information

Informational text is written to tell, show, describe, or explain. A good reader looks for structure in text and can easily make a distinction between important ideas and unimportant ideas in informational text. As teachers, we should help students identify text patterns that help them make these distinctions. Five text patterns that seem to dominate informational text include:

- Description
- Problem/Solution
- Compare/Contrast
- Cause/Effect
- Sequencing

Informational writing is not written in neat, identifiable patterns. Most informational text is written with a descriptive text structure. Within text, the author may begin the passage with a problem, then go on to describe the events contributing to the problem. Or perhaps the author will compare or contrast the problem in relation to another problem. Throughout the text, the author may present the solution in a descriptive text pattern. These descriptions and explanations may be organized in a sequence pattern. Therefore it becomes difficult to analyze the text pattern.

However difficult it might be, students must learn how to recognize and use text patterns in informational text. When readers understand and interact with text organization, they are prepared to comprehend and remember the information.

Invitation to Learn

Show a narrative and an informational text. Ask the students if they can identify any differences between the two types of writing. Encourage them to identify the text features that show differences. Some differences that may be discussed include: real photographs, table of contents, captions, indexes, glossary, informational charts, etc. These are all external text structures that are important for students to understand, however the internal text structures are more important to understand. Internal text structures are patterns of organization that show, tell, describe, or explain.

Instructional Procedures

Materials

- ❑ Classroom science textbooks
- ❑ A variety of informational trade books
- ❑ Text structure examples
- ❑ *Organizational Pattern Signals* (Blank)
- ❑ *Organizational Pattern Signals* (Completed)

How do you teach students about text structures in science?

- Teach explicitly.
- Model reading and writing the various structures.
- Students must interact with various text structures (e.g., textbooks, trade books, Internet, etc.).
- Teach only one structure at a time.
- Reinforce structures all year long.
- Allow time for students to practice and apply the skills they have learned.
- Use time in the literacy block to teach literacy ideas using science texts.

Teachers need to use examples of content text to teach text structures. Text structures represent different types of connections among important and unimportant ideas in nonfiction text. Begin by defining each text structure. As students understand and can identify the text structures, they can begin to incorporate them into their own writing.

Description

Definition: "Providing information about a topic, concept, event, object, person, idea, and so on (facts, characteristics, traits, features,) usually qualifying the listing by criteria such as size or importance. This pattern connects ideas through description by listing the important characteristics or attributes of the topic, under consideration. The author describes a topic by listing characteristics, features, and examples" (*Content Area Reading*).

Description Example: "All living things fit into one of six kingdoms: Protista, Plantae, Fungi, Animalia, Eubacteria, or Archaebacteria. Bacteria make up the kingdoms Eubacteria (YOO bak TIR ee uh) and Archaebacteria (AHR kee bak TIR ee uh). These two kingdoms contain the oldest forms of life on Earth. All bacteria are single-celled organisms. Bacteria are usually one of three main shapes: bacilli, cocci, or spirilla" (*Microorganisms, Fungi, and Plants*).

Multiple Examples: Like living things, viruses contain protein and genetic material. But viruses don't act like living things. They can't eat, grow, break down food, or use oxygen. In fact, a virus cannot function on its own. A virus can reproduce only inside a living cell that serves as a host. A host is a living thing that a virus or parasite lives on or in. Using a host's cell as a tiny factory, the virus forces the host to make viruses rather than healthy new cells" (*Microorganism, Fungi, and Plants*).

Problem/Solution

Definition: "Showing the development of a problem and one or more solutions to the problem. The author states a problem and lists one or more solutions for the problem. A variation of this pattern is the question-and-answer format in which the author poses a question and then answers it" (*Content Area Reading*).

Problem/Solution Example: "Although human eyes cannot sense infrared, there are ways of detecting it. One is to use film that senses infrared. There are also electronic sensors that detect infrared. They are carried on satellites-the Landsat series launched by the United States and satellites launched by other countries. The sensors scan the earth beneath them. They measure the light reflected by the earth, both the wavelengths we see and the infrared. The sensors are another kind of remote sensing" (*Seeing Earth From Space*).

Multiple Examples: "What was the most famous repair job in space? Fixing the Hubble Space Telescope. It didn't work perfectly at first. One of its mirrors was a bit too flat. This blurred the images. Also, there was a slight wobble as the satellite traveled in orbit. In 1993, NASA sent astronauts up in a shuttle to repair the Hubble. They caught the telescope with a 50-foot (15.2 m) robot arm and pulled it into he shuttle's open cargo bay. Working in space suits, they replaced some parts, added new instruments, and launched it back into orbit. Four years later, NASA scientists improved the Hubble even more by attaching several advanced pieces of equipment to the telescope" (*Can You Hear a Shout in Space?*).

Compare/Contrast

Definition: "Pointing out likenesses (comparison) and/or differences (contrast) among facts, people, events, concepts, and so on. The author explains how two or more things are alike and/or how they are different" (*Content Area Reading*).

Compare/Contrast Example: "The Sun dominates our location in space. It is quite different from the planets and all the other bodies in the solar system. The Sun is a star, just like the stars we see in the night sky, but much closer to Earth. It is a great ball of very hot gas that gives out vast amounts of energy as light and heat. In contrast, the other bodies in the solar system are made of rock, ice, or cold gas. And they give out no light of their own. We see them shining in the night sky only because they reflect light given off by the Sun" (*Kids Discover Magazine—Solar System*).

Multiple Examples: "Earth is surrounded by an atmosphere that protects all the plants and animals on the planet from the extreme conditions in space. It shields us from the sun's radiation, helps us keep our planet warm, and contains the oxygen that many of Earths creatures need to survive. Mars, too, has an atmosphere, but it is very different from Earth's. The Martian atmosphere is very, very thin and is made up almost entirely of carbon dioxide. Fine red Martian dust fills the thin air and creates a pink sky all year round" (*The Mystery of Mars*).

Cause/Effect

Definition: "Showing how facts, events, or concepts (effects) happen or come into being because of other facts, events, or concepts (causes). The author lists one or more causes and the resulting effect or effects" (*Content Area Reading*).

Cause/Effect Example: "When sound waves hit an object, some of them bounce back toward their source. This bounce is an echo. Some animals use this echo effect to help them survive. They send out sounds that bounce off objects and other animals. (Many of these sounds are too high-pitched for humans to hear.) The echoes of the sounds then bounce back to the source animal. This is called echolocation. The bouncing sounds help the animals "see." Echolocation helps them find food and move around without bumping into things" (*Physics of Sound*).

Multiple Examples: "If you spot some dust around your house you probably think, Time for a clean up! But wait a second; is it just dust that you're getting rid of? Would you believe that you're

disturbing a dust mite and maybe a few thousand more like it? Now this doesn't look like something you would want to upset, does it? Except that there's more here than meets the ordinary eye. We're going down the microscope into a dusty world because of a little dust…" (*Yuck!*).

Sequencing

Definition: "Putting facts, events, or concepts in order. The author traces the development of the topic or gives the steps in the process. Time reference may be explicit or implicit, but a sequence is evident in the pattern. The author lists items or events in chronological order" (*Content Area Reading*).

Sequence Example: "Dennis lowered collecting bottles on ropes. The bottles had triggers so Dennis could open them at different depths. This allowed him to collect some water samples from near the surface and others from deep in the lakes. The first water samples the scientist collected showed that some of the lakes were completely dead. Nothing had survived the heat, gases, and choking ash of the eruption. Just a few weeks later, Dennis used microscopes to look at new water samples he had collected from the same lakes. He was amazed to see algae, protozoan, and bacteria living in the water. Within several months, small crustaceans—animals that feed on algae and bacteria—began to reappear in some of the lakes (*Hidden Worlds: Looking Through a Scientist's Microscope*).

Multiple Examples: "The Planet closest to the Sun is Mercury, then comes Venus, and next is Earth. We are number three. That should be an Earthling's loudest cheer. Because of Earth's distance from the Sun, it alone has the right temperature for liquid water-vital to life. Just look at Venus. At 900 degrees Fahrenheit, water turns to vapor. And on Mars, the next planet after Earth from the Sun, all the water is frozen at the poles" (*Kids Discover Magazine—Solar System*).

Activity

1. With your group, make a list of the signal words in the texts that helped you identify the text structure.
2. Provide a variety of textbooks, trade books, Internet pages, etc. to help students identify the different text structures.
3. Distribute blank *Organizational Pattern Signals* (p. 3-10). See completed *Organizational Pattern Signals* (p. 3-11).
4. Have students list signal words found in the sample texts.

Assessment Suggestion

Once a text structure is thoroughly understood, students can use curriculum content and the *Organizational Pattern Signals* to write their understanding of each content concept. Informal assessment determines if they understand the text structure.

Write expository compositions (e.g., description, explanation, compare/contrast, and/or problem/solution) that:

1. State the thesis or purpose.
2. Explain the situation.
3. Follow an organizational pattern appropriate to the type of composition (e.g., if problem/solution, then paired).
4. Offer persuasive evidence for the validity of the description, proposed solutions, etc.

Additional Resources

Content Area Reading: Literacy and Learning Across Curriculum, by Joanne and Richard Vacca (Pearson Allyn & Bacon, 7th edition, July 9, 2001); ISBN 0321088107

Physics of Sound (Bouncing Back), by Michael Burgan and Dona Smith (Delta Education, FOSS™ Science Stories); ISBN 0-87504-835-8

Hidden Worlds: Looking Through a Scientist's Microscope, by Stephen Kramer (Houghton Mifflin Co., Boston); ISBN 0-618-05546-0

The Solar System (Exploring the Universe), by Robin Kerro (Raintree Steck-Vaughn); ISBN 0-7398-2817-7

Kids Discover—Solar System, by Stella Stands, Mark Levin, 149th Fifth Avenue, New York, NY 10010. ISSN 1054-2868

The Mystery of Mars, by Sally Ride and Tam E. O'Shaughnessy (Scholastic, Inc.); ISBN 0-439-18027-9

Seeing Earth from Space, by Patricia Lauber (Scholastic Inc., 1990); ISBN 0-590-68691-7

Can You Hear A Shout in Space?, by Melvin and Gilda Berger (Scholastic Inc., 2000); ISBN 0-439-09582-4

Yuck!: A Big Book of Little Horrors, by Robert Snedden (Simon & Schuster, New York, 1996); ISBN 0-689-80676-0

Microorganisms, Fungi, and Plants, (Holt Science & Technology); ISBN 003064772X

Possible Extensions/Adaptations/Integration

- Can you get the paper circles in your tray to move, using only your balloon, without touching the circles or using any air? Describe what you did to make your paper circles move. (cause/effect)
- Using the tools provided, make observations of your ice hand every ten minutes and record your observations in a log. Describe how your ice hand changed over time. (time sequencing)
- Create a model of the solar system using food. Your model should be accurate in terms of relative size, distance, and color. Explain how your model compares to the actual solar system. (compare/contrast)
- Create a microorganism museum. Your group will create a model of your assigned microorganism and write a description for museum guests. (description)

Organizational Pattern Signals

Signal Words	Description	Problem/Solution	Compare/Contrast	Cause/Effect	Sequencing	Listing

Organizational Pattern Signals

Signal Words					
Description	**Problem/Solution**	**Compare/Contrast**	**Cause/Effect**	**Sequencing**	**Listing**
• is • for example • involves • can be • defined • an example • for instance • in fact • also • contain • make up	• a problem is • a solution is • the problem is • is solved by • a potential alternative is • solution • issue • a possible answer • therefore • conclusion	• different from • same as • alike • like • similar to • unlike • but • as well as • yet • either...or • not only...but also • compared to • in contrast • while • resembles • although • unless • similarly • however	• so that • because of • thus • unless • therefore • since • in order to • as a result of • this led to • then • reasons for • if...then • consequently • an explanation for • this reason • nevertheless • thus accordingly	• first • second • third • now • before • after • then • next • finally • following • while • meanwhile • last • during • not long • when • on (date)	• to begin with • first • second • in addition • next • then • last • finally • another • also • most important

Graphic Organizers Bring About Good Science Reading and Writing

Language Arts Standard VII

Objective 2

Language Arts Standard VII:
Comprehension—Students understand, interpret, and analyze informational grade level text.

Objective 2:
Apply strategies to comprehend text.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII-1, 6

Connections

Background Information

This activity emphasizes the importance of teaching reading and writing strategies for students to use with informational text. A student who has been taught reading and writing together has the necessary tools to explore, clarify and think deeply about the ideas and concepts they encounter in reading. There is no better way to think about a subject than to take the opportunity to read and write about it.

Teachers who use reading and writing together help students think about what they will read, and understand what they have read. Teachers should plan instruction that leads to active text learning. Students need to act on ideas in print and also interact with one another when learning with text. This instruction model provides ideas for pre-reading, reading, and post-reading instruction for Core Curriculum text lessons. The use of graphic organizers provides the structure for bringing learners and texts together using multiple texts.

In planning a unit, the teacher should construct a graphic organizer of the major concepts, and then identify literature for group and individual investigation. Before actually assigning a graphic organizer to students, the teacher should prepare for the activity by carefully analyzing the vocabulary of the material to be learned. List all the terms that are essential for students to understand. Finally, construct your own organizer.

Graphic organizers are easily adapted to learning situations in the elementary grades. For whole class discussion, construct your graphic organizer on a large sheet of chart paper or on your chalk/white board.

Ultimately, the student should learn how to create and use different types of graphic organizers to understand, interpret, and analyze informational text. The form of the student-constructed graphic organizer

will undoubtedly be different than the teacher's arrangement. However, this difference should not be a major source of concern.

Graphic Organizer Samples (see p. 3-17)

- Venn Diagram (compare/contrast)
- Problem/Solution
- Hierarchy (listing)
- Time Line (time)
- Cluster Diagram (description, order of importance)
- Flow Chart (cause/effect, problem/solution)

Teaching Graphic Organizers

- Model the use of graphic organizers.
- Provide opportunities for guided practice.
- Provide opportunities for independent practice.

Graphic organizers encourage students to make connections with the text by creating a structure for students to explore text and consider different sides of an issue in discussion before drawing conclusions.

1. Prepare your students for reading by activating prior knowledge, raising questions, and making predictions about the text.
2. Assign students to read the selection, then introduce the graphic organizer. Have the students work in pairs to generate a completed graphic organizer.
3. Combine pairs into groups of four to compare responses, work together toward consensus, and reach a conclusion as a group.
4. Give each group three minutes to decide which of all the reasons given best supports the group's conclusion.
5. Have your students follow up the whole class discussion by individually writing their responses on the graphic organizer (not necessary every time).

Invitation to Learn

Use this approach to activate prior knowledge, raise questions, or make predictions about the text. Ask, "How many different things do you know about the chosen topic to be studied?" Brainstorm ideas, vocabulary words, or major concepts about a given topic. As the students suggest different ideas, create a graphic organizer on the board. Let students make the connections that they understand. Later, after reading text, doing an experiment, or hands-on activity, the students can make any necessary changes to the class-generated graphic organizer.

Instructional Procedures

Materials

- ❏ Pens/pencils
- ❏ Informational text readings from Internet or newspapers
- ❏ Science classroom textbook
- ❏ Variety of trade books and informational text
- ❏ *Graphic Organizer Samples*
- ❏ Posters of the *Graphic Organizer Samples*

Constructing the Graphic Organizers as a Pre-assessment (Whole Group Participation)

1. List all the vocabulary words/word phrases/pictures that students give about the content area topic.
2. Arrange the list of words until there is a scheme that shows the connections among the concepts particular to the learning task.
3. Evaluate the organizer. Ask, "Can the organizer be simplified and still effectively communicate the ideas you consider crucial?"
4. Introduce students to a previously determined section of the text to read. Allow them to compare and evaluate their own understanding according to their reading. Experiments and hands-on activities for connections to learning may also be used.
5. After reading, discuss as a class any additional information learned that may be added to the graphic organizer.

Modeling for the Students How to Make Their Own Connections (Small Group Participation)

1. Type the keywords/word phrases/pictures and make copies for the students to use.
2. Have students form small groups of three to four students each.
3. Distribute the list of terms, pictures, major concepts, and chart paper to each group.
4. Have them work together to decide on a spatial arrangement of the words that depicts the connections between the words.
5. As students work, offer assistance as needed.
6. Provide reading text to increase content area information.
7. Initiate a discussion of the constructed organizer.

Allowing the Students to Use a Teacher-created Graphic Organizer (Individual Participation)

1. Prepare the organizer with a schema that shows the interrelationships among the concepts particular to the learning task.
2. Provide a blank graphic organizer with some connections made, the remaining will be completed by the student.
3. Provide a reading passage that furnishes information with key concepts for students to locate and add to the graphic organizer.

4. As students add specific information/vocabulary words to the graphic organizer, create as much discussion as possible.

Activity

1. Model a graphic organizer that can be used with Core Curriculum content.
2. Using trade books, textbooks, or other content area readings, have the student transfer identified information onto a graphic organizer.
3. Teachers should scaffold every graphic organizer many times to prepare students to create their own graphic organizer.
4. Scaffolding also applies to the writing assignments. Students need to be taught how to write a summary, a compare and contrast paper, a description paper, and a question and answer paper. Ability to complete a graphic organizer does not indicate that the student knows how to accomplish the writing task.
5. Students should engage in a writing activity after each text reading and completion of a graphic organizer.

Assessment Suggestions

- Construct a graphic organizer as an assessment. Give the students a blank graphic organizer to complete using a given list of vocabulary words, pictures, or description word phrases.
- Have students use the graphic organizer to write an expository paper reflecting what they learned.

Additional Resources

Other graphic organizers may be found on the Internet.

Visit any one of these sites for more examples of graphic organizers

http://www.graphic.org/goindex.html

http://www.writedesignonline.com/organizers/

http://www.ncrel.org/sdrs/areas/issues/students/learning/lr1grorg.htm

Possible Extensions/Adaptations/Integrations

- Create a graphic organizer with your class according to the content of your texts:

  Moon Cycle = Time Sequencing

  Solar System = Compare/Contrast

  Microorganism = Cause/Effect

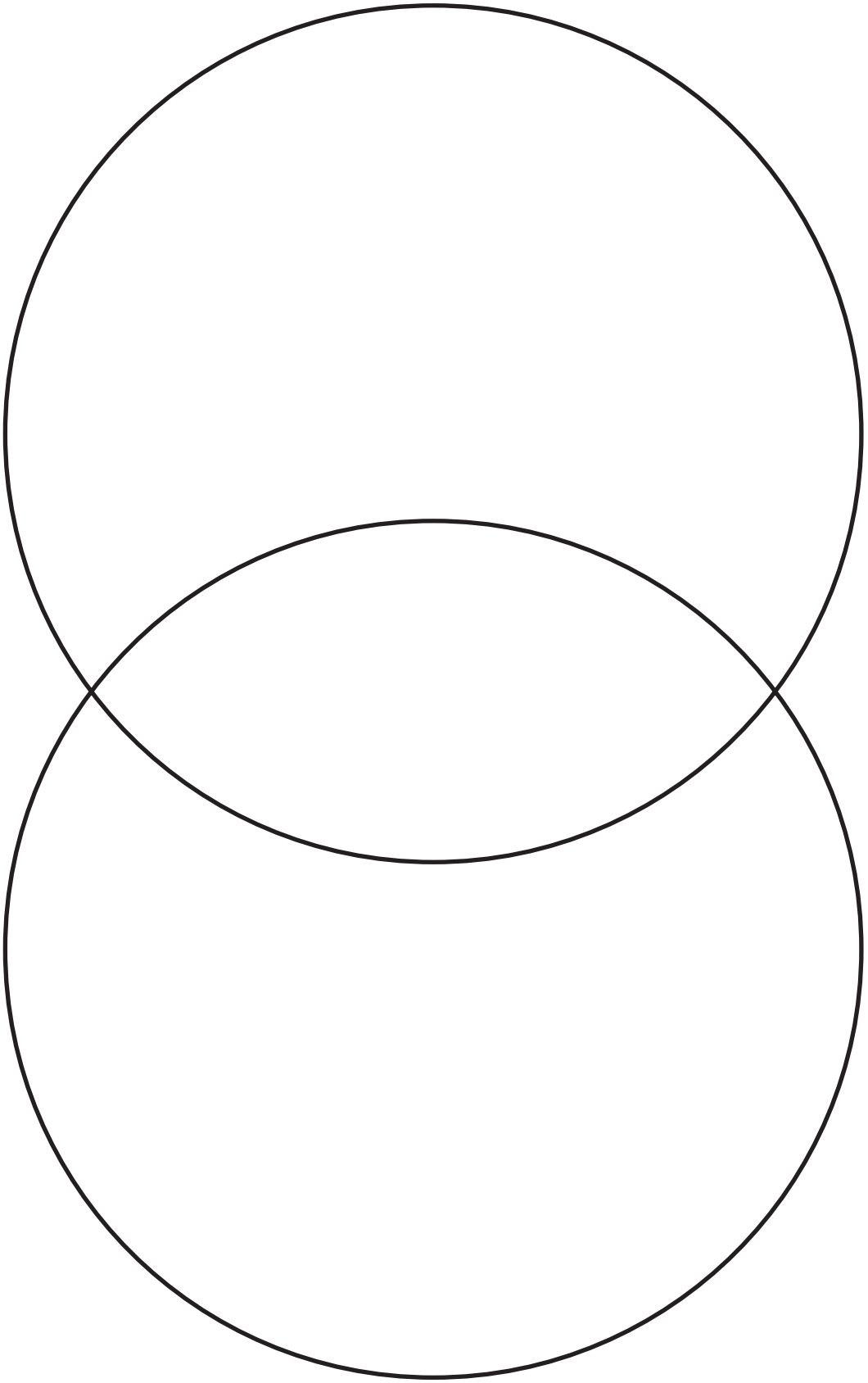
  Heat, Light, Sound = Problem/Solution

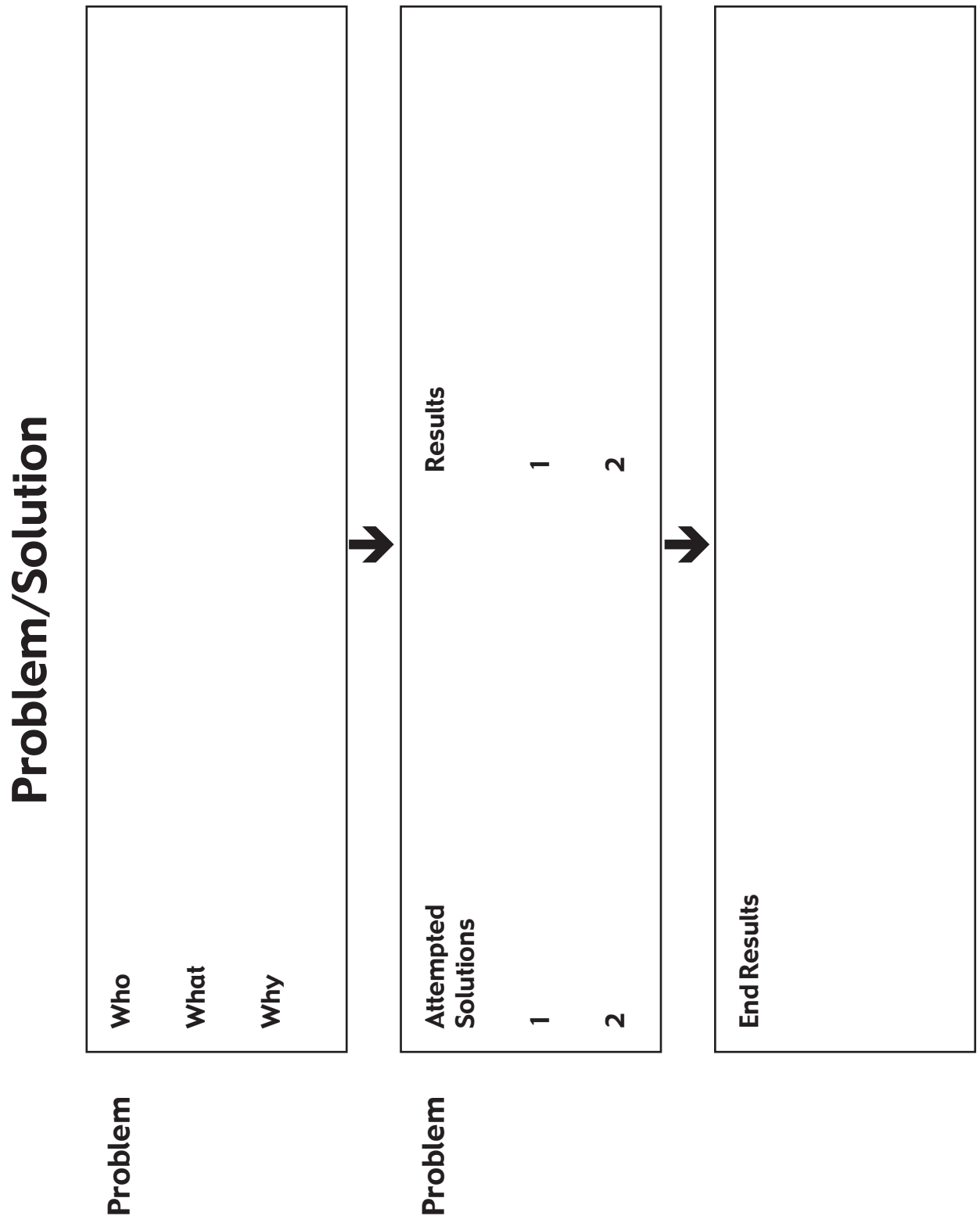
  Planets in our Universe = Listing

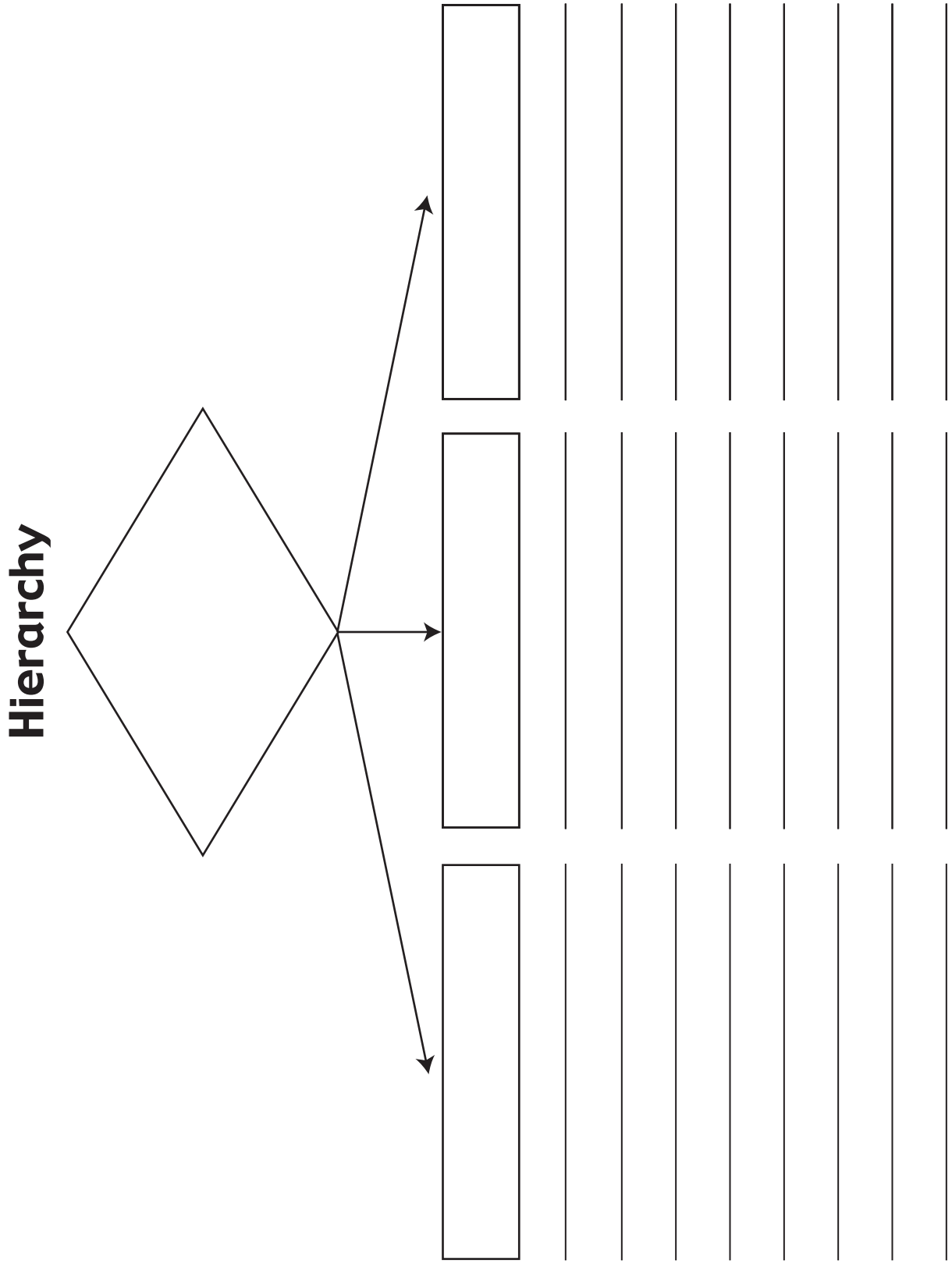
- Convert graphic organizers into writing assignments.
- Teach the students to use other graphic organizers while reading nonfiction trade books. Graphic organizers should be taught one at a time. Use different graphic organizers before, during, and after any hands-on group activity, experiment, or when reading informational text. Use graphic organizers when viewing informational videos to engage the students in listening and comprehending science concepts.

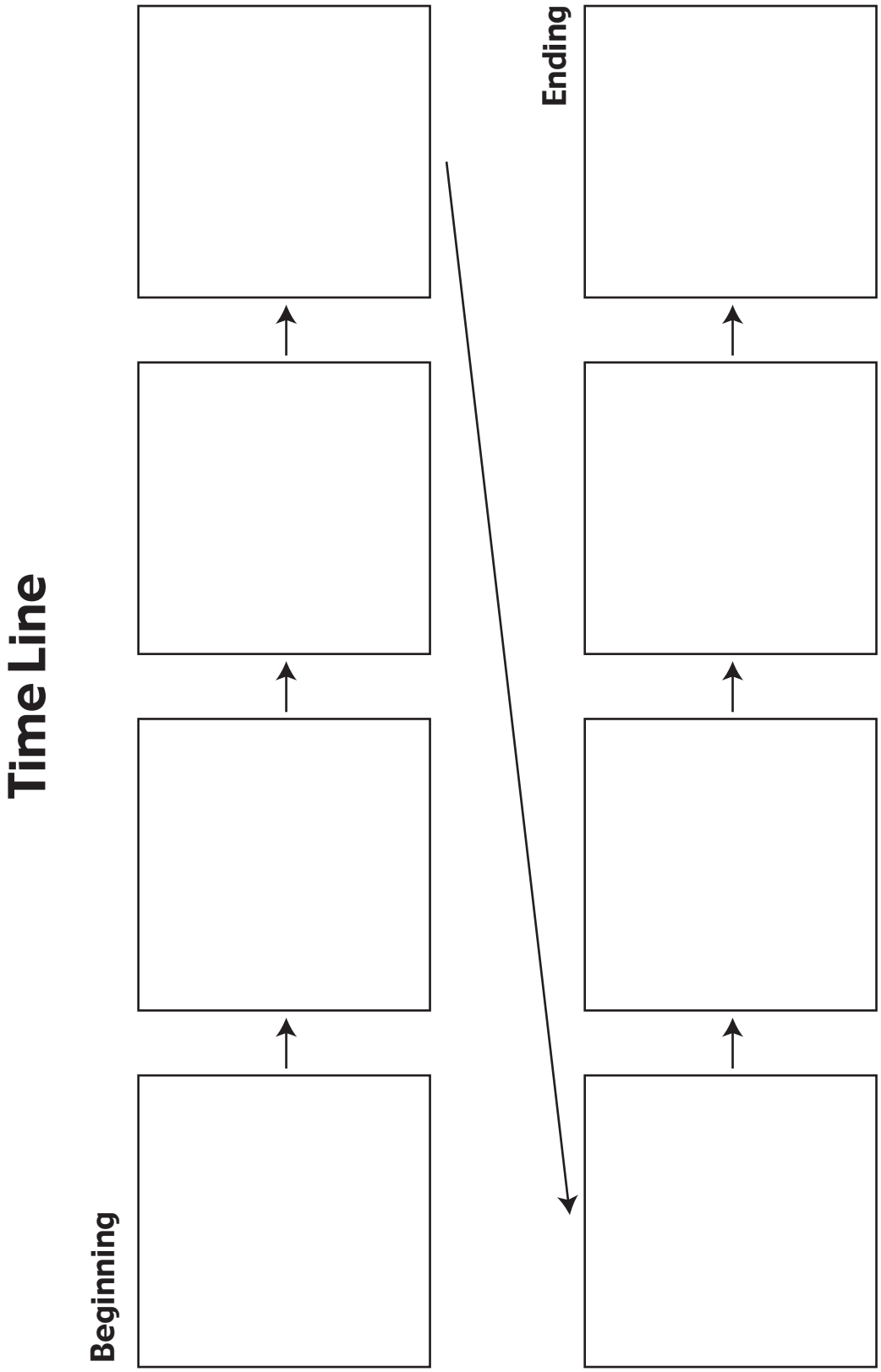
Graphic Organizer Samples

Venn Diagram

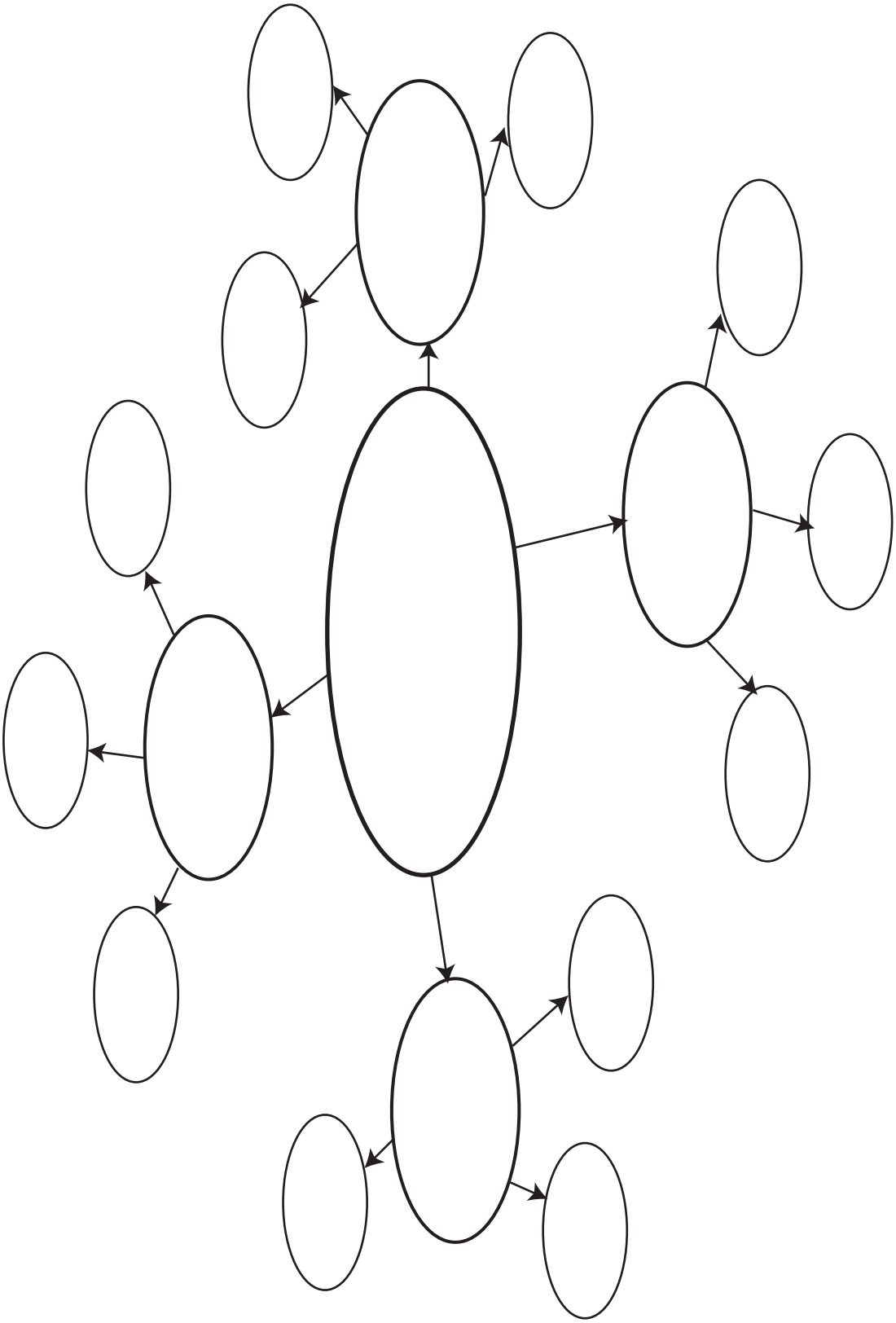



Problem/Solution
Problem
Who
What
Why
Problem
Attempted Solutions
1
2
Results
1
2
End Results

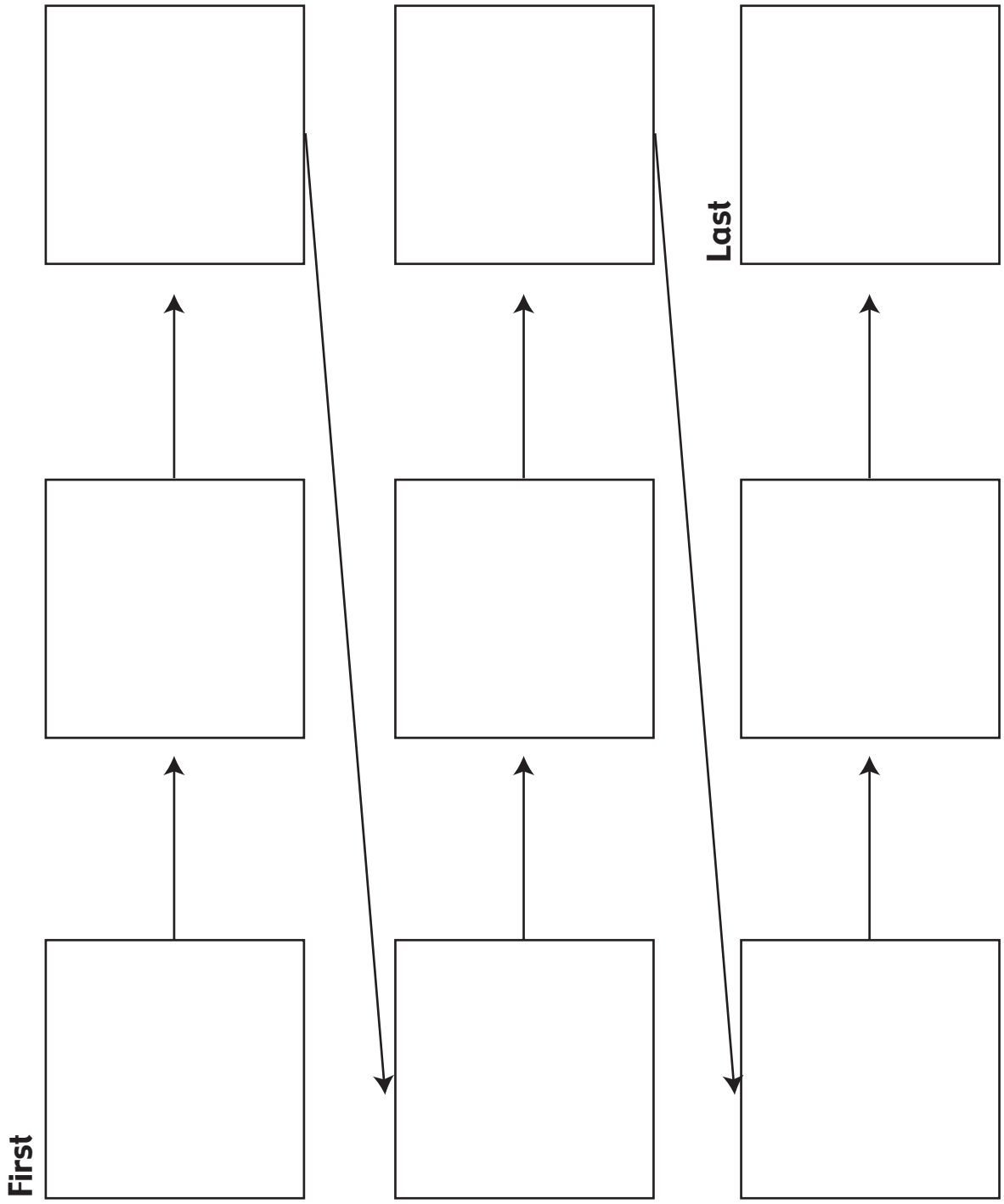

Hierarchy


Time Line
Beginning
Ending

Cluster Diagram



Time Sequencing Flow Chart



Science
Standard V
Activities

Microbes On My Mind

Science Standard V:
Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 1:
Observe and summarize information about microorganisms.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VIII-6, VII-2, 3

Science Standard V

Objective 1

Connections

Background Information

Microbes are small living forms of life that cannot be seen without the help of a microscope. As a result, these tiny one-celled organisms are known as microorganisms. Microorganisms are as real and alive as you are. They eat and grow; they reproduce and die.

Microbes can be found everywhere. They live in almost all natural conditions where moisture is found. They may be found in fresh water ponds, soil, salty water, hot springs, or snow drifts. They are present on animals, people, and even in the air we breathe.

Invitation to Learn

Ask students what they know about microorganisms. What are they? How do they move? What do they eat? Where do they live? What is their purpose? Create a class cluster on the ideas the students give you. (Display the cluster throughout the unit so students can refer back to it and see what they might change or add.)

Instructional Procedures

Day One

1. Divide students into groups of four to five.
2. Hand each student a copy of the *Kids Discover Magazine—Microbes* and an envelope with the cut out *Microorganism Words/Phrases* (p. 4-6).
3. Have each group read the magazine pages and create their own cluster.
4. Collect clusters so groups can add more details later.

Materials

- ❑ *Kids Discover Magazine—Microbes* (one per student)
- ❑ *Microorganism Words/Phrases* (cut out and in an envelope, one set per group)
- ❑ Books on microorganisms
- ❑ Protozoa (from pond water, hay infusion, or purchased in advance)
- ❑ Depression slides
- ❑ Cover slips
- ❑ Microscopes
- ❑ Eye dropper

Day Two

1. Collect protozoa from local pond water by making a hay infusion, or order them in advance.
2. Using an eyedropper, suck up some protozoa and squirt it into a depression slide, then cover with a cover slip.
3. Have students use a microscope to observe protozoa.
4. Ask students to draw what they observe and add drawings to their clusters in the appropriate area.
5. Look at bacteria slides under the microscope and draw observations; add to cluster.

Day Three

1. Have students get back into their groups.
2. Pass out a different microorganisms book to each group.
3. Have groups read through the books and add details to their clusters. Have them look for characteristics of organisms (e.g., color, movement, appendages, shape, size, etc.) and requirements of microorganisms (i.e., food, water, waste disposal, temperature of environment, reproduction, etc.).
4. After about 15 minutes, have groups exchange books and see if they can find more details.
5. Exchange books until each group has enough information to create a detailed cluster.
6. As a class, discuss how group clusters compare to the class cluster made the first day. What are the similarities? Differences?

Day Four

1. Have students use their clusters and drawings to create an information book on microorganisms.

Possible Extensions/Adaptations/Integration

- Integrate with social studies and the Black Plague.
- Use Venn Diagrams to compare characteristics in observed organisms.
- Create a PowerPoint presentation on microorganism requirements.

Assessment Suggestions

- Informal assessment includes the clusters, drawings, and observations of groups during the activities.
- Formal assessment is the microorganisms book.

Additional Resources

Books/Magazine

Kids Discover Microbes Magazine; ISBN 1054-2868

Slime Molds and Fungi, by Elaine Pascoe; ISBN 1-56711-182-3

Single-Celled Organisms, by Elaine Pascoe; ISBN 0823963128

Fungi, by Elaine Pascoe; ISBN 0-8293-6313-6

Microorganisms: The Unseen World, by Edward R. Ricciuti; ISBN 1-56711-040-1

A World of Microorganisms, by Robert Snedden; ISBN 1-57572-241-0

My Health—What Are Germs?, by Dr. Alvin Silverstein, Virginia Silverstein, and Laura Silverstein Nunn; ISBN 0-531-16640-6

Web sites

http://www.microbe.org/index.html

http://www.amnh.org/exhibitions/epidemic/

http://bird.miamisci.org/microbes/facts18.html

http://www.xenob.com/mic!.htm

http://www.ucmp.berkeley.edu/bacteria/bacterialh.html

http://biology.about.com/science/biology/library/weekly/aa052997.htm

Family Connections

- Have students quiz family members on what they know about microorganisms.
- Have students read their microorganisms book to their family.
- Look in a grocery store advertisement and write down all the foods in the ad that have a relationship to microorganisms. Remember foods like spaghetti sauce may contain mushrooms and foods containing dough have yeast.

Microorganism Words/Phrases

Types of Microbes	**Bacteria**
Protists	**Fungi**
Viruses	**Rod-shaped**
Spiral shaped	**Spherical-shaped**
Causes diseases— like typhoid fever and cholera.	**Causes diseases—** like polio, rabies, chicken pox, and measles.
Algae	**Protozoa**

Live by absorbing nutrients from dead or decaying life forms.	**Make their own food using photosynthesis.**
Mushrooms	**Yeast**
Mold	**Mildew**
Slime molds	**Involved in fermentation**
Can't live unless they invade something else	

The Good, the Bad, and the Both

Science Standard V

Objective 3

Connections

Science Standard V:
Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 3:
Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VIII-6, VII-2, 3

Background Information

Microorganisms are tiny creatures that can be harmful or helpful. They are responsible for human diseases such as food poisoning, typhoid fever, cholera, and pneumonia. However, microorganisms are helpful in breaking down dead animals and plants and making their chemicals available to other organisms. Animals depend on microorganisms for digestion. Microorganisms are also responsible for turning milk into yogurt, cheese, and butter.

Invitation to Learn

Ask students if they know any helpful aspects of microorganisms; list them on one side of a T-chart on the overhead. Ask students if they know harmful aspects of microorganisms; add on the other side of the T-chart.

Instructional Procedures

Materials

- ❑ Articles on microorganisms (specifically positive and negative effects)
- ❑ Books on microorganisms (specifically positive and negative effects)

Day One

1. Put students into groups for a jigsaw activity. The number of students in each group depends on the number of articles you have. (If you have five articles, you should have five students in each group.)
2. Explain to the students that this is their home group and they will return to the same group later on in the activity.
3. Pass out the articles on the positive and negative effects of microorganisms. Make sure that each person in the home group has a different article than the other members of that group.

4. Put students into new groups based on what article they have—they will be working with students who have the same article.
5. Each group reads and discusses the article to become "experts" on that particular article.
6. Have students return to their home group. Each student will teach their home group about the important aspects of the article they read.
7. Have students create their own T-chart listing the positive and negative effects of microorganisms.
8. Have a class discussion on the effects of microorganisms; add new information to the class T-chart.

Day Two

1. Create learning centers with books about microorganisms.
2. Put students into groups and have them rotate through the different centers.
3. Tell students to look for positive and negative effects of microorganisms that can be added to their T-chart.
4. Have students write a paragraph on the positive effects of microorganisms and one on the negative effects of microorganisms using individual T-charts. Make sure the students use key words as they expand the paragraphs into a compare/contrast paper.

Possible Extensions/Adaptations/Integration

- Have a class debate on the positive and negative effects of microorganisms.
- Have students write a persuasive paper on whether they believe microorganisms are more harmful or more helpful.

Assessment Suggestions

Assessment includes individual T-charts and paragraphs on positive and negative effects of microorganisms.

Additional Resources

Books/Magazine

Kids Discover Microbes Magazine; ISBN 1054-2868

Germs, by Don Nardo; ISBN 0-7377-0943-X

Decomoposers in the Food Chain, by Alice B. McGinty; ISBN 0-8239-5757-8

The Benefits of Bacteria, by Robert Snedden; ISBN 1-57572-242-9

Fungi, by Elaine Pascoe; ISBN 0-8239-6313-6

Microorganisms: The Unseen World, by Edward R. Ricciuti; ISBN 1-56711-040-1

My Health—What Are Germs?, by Dr. Alvin Silverstein, Virginia Silverstein, and Laura Silverstein Nunn; ISBN 0-531-16640-6

Web sites

http://www.microbe.org/index.html

http://www.amnh.org/exhibitions/epidemic/

http://bird.miamisci.org/microbes/facts18.html

http://www.xenob.com/mic!.htm

http://www.ucmp.berkeley.edu/bacteria/bacterialh.html

http://biology.about.com/science/biology/library/weekly/aa052997.htm

Family Connections

- Look at food in a refrigerator or pantry to find food that used microorganisms in the food processing.
- Look for food in a refrigerator or pantry that uses preservatives to help prevent the growth of microorganisms.

Science Standard I Activities

Moon Light Through the Month

Science Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits the Earth.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts I-1, II, III, IV-1, 2, 3

Science Standard I

Objective 1

Connections

Background Information

Even though it has no light of its own, the moon is the brightest object in the evening sky because it reflects sunlight. As the moon revolves around Earth, the shape of the moon appears to change. This is caused because of the relative position of Earth, sun, and moon. The moon appears to change because different amounts of light illuminate the surface of the moon that faces us. This light we see changes from day to day as the moon orbits Earth, letting us see more or less of the moon's surface.

Half of the moon's surface is always in the sunlight. We see the moon going through phases because of the varying positions of the sunlit side of the moon as it revolves around Earth. This sunlit face we see can range from a thin crescent to a full face. When the side of the moon facing us has no sunlight on it, we cannot see it at all. We call this a *new moon*. The *lunar month*, which lasts 29.5 days, is measured from one new moon to the next.

Invitation to Learn

Students work in cooperative groups in this activity.

- The goal is to circle as many CONSECUTIVE numbers as possible in two minutes.

  Rule: Students keep the paper turned over until you say "Go."
- Each *Consecutive Numbers* handout has the numbers arranged in a different order, so it isn't a question of memorizing, it's a question of communication.

Materials

- ❑ *Consecutive Numbers #1* handout (blue)
- ❑ *Consecutive Numbers #2* handout (pink)
- ❑ *Consecutive Numbers #3* handout (yellow)

Test one

Each person is to complete his/her own sheet without talking.

1. Distribute *Consecutive Numbers #1* handout (p. 5-8) to each person.
2. Have each student write his/her name on the back.
3. Have students turn the paper over and begin circling the numbers in order.
4. After two minutes, say "Stop." Students write the last number they circled in the upper right hand corner.

Test two

Have students pair up. This time they may point to the numbers and work together, but they cannot talk.

1. Distribute *Consecutive Numbers #2* handout (p. 5-9) to each pair of students.
2. Have students put both names on the back.
3. Have students turn the paper over and begin circling the numbers in order.
4. After two minutes, say "Stop." Students write the last number they circled in the upper right hand corner.

Test three

Have students work with the same partners. This time they can talk.

1. Distribute *Consecutive Numbers #3* handout (p. 5-10) to each pair of students.
2. Have students put both names on the back.
3. Have students turn the paper over and begin circling the numbers in order.
4. After two minutes, say "Stop." Students write the last number they circled in the upper right hand corner.

Hold pair and table discussions:

- Ask which test had the best results. Why?
- Ask what observations they made and what conclusions they came to.
- Reinforce that better results come with teamwork and group cooperation.
- For the next several lessons we will be working in groups. It is important for us to learn to work together so that we get better results. Scientists use cooperation all the time.

Instructional Procedures

1. Distribute materials to each table or group of four to six students.
2. Have students arrange *Moon Phase Phrase Cards* (p. 5-11) in sequential order on chart paper.
3. Go around to each group and observe, taking notes on how they have arranged them.
4. Monitor the progress of each group until all groups have finished and they are satisfied with their charts.
5. Next, distribute *Moon Phase Picture Cards* (p. 5-11). Have students match pictures with *Moon Phase Phrase Cards*.

   Note: You may want to print each set of *Moon Phase Picture Cards* on a differrent color of cardstock (one color for each table or group) for ease in collecting them.
6. Hand out *Moon Phase Cluster Word Cards* (p. 5-11) and have students match them to the *Moon Phase Phrase Cards* and *Moon Phase Picture Cards*.
7. Use any instructional text covering phases of the moon. Instruct each group to read and reread a selected passage to see if it checks with their sequence graphic. They may opt to change any text or picture of their choice after reading.
8. Have each group check and make any changes to their poster so it looks like they want. Next, have a person from each group come up and explain their chart.

   Note: Be sure to ask them if they made any changes in their original clustered poster after they read the informational page.
9. Keep these posters up for the entire unit for reference.

Materials

For each group:

- ❏ *Moon Phase Phrase Cards*
- ❏ Large chart paper or poster
- ❏ *Moon Phase Picture Cards*
- ❏ *Moon Phase Cluster Word Cards*
- ❏ Colored markers
- ❏ Tape
- ❏ Instructional Text

Possible Extensions/Adaptations/Integration

Moon Phase Extension Cards

1. Distribute materials to each group.
2. Each group will choose (or you can assign) a pair of words from below.
   - New/Full
   - Waxing/Waning
   - First/Last

Materials

For each group:

- ❑ *Moon Phase Picture Cards*
- ❑ *Moon Phase Cluster Word Cards*
- ❑ Eight plain 3" x 5" index cards
- ❑ Two different colored markers
- ❑ 20 inches masking or clear tape
- ❑ Thesaurus

- Crescent/Gibbous
- Solar (Sun)/Lunar (Moon)
- Seasons/Yearly
- Tilt/Straight
- Orbits/Stationary
- Revolution (Revolves)/Stationary
- Reflection/Light
- High Tide/Low Tide

Note: Crescent/gibbous and solar/lunar may be found in science dictionaries or on a writing program thesaurus.

3. Have each group write their two words on the index cards in the same color or marker.
4. Each group then looks up their words in the thesaurus. They need to find four synonyms for each word. Then write one synonym on each of the cards in the other color of marker.
5. As a group, discuss the four synonyms for each word and arrange them from one extreme to the other (e.g., pretty = charming, handsome, lovely, beauteous, fair, elegant).

   These words might then be arranged from pretty=handsome, fair, elegant, beauteous.

   After the words are arranged, tape them together in a vertical line.
6. Each group shares and discusses their words with the class. Display the work in the classroom for reference throughout the unit.
7. As a review, have students predict or match the *Moon Phase Picture Cards* to the *Moon Phase Cluster Word Cards*. Walk around to each table and monitor the progress. Students may use materials from the lesson.
8. After each of the student groups have arranged the cards, use an enlarged set of the same set of cards and show the matching pairs.

Assessment Suggestions

- Have students complete the *Drawing Moon Phases* worksheet (p. 5-15).
- Have students complete the *Matching Moon Phases* worksheet (p. 5-16).

  Note: Waxing Crescent and Waning Crescent and Waxing Gibbous and Waning Gibbous are not required in the sixth grade Core Curriculum. These are presented to you as optional material and possible extensions.

Additional Resources

Books

More Universe at Your Fingertips (Project Astro), edited by Andrew Franknoi; ISBN 1-886733-98-8

Scholastic Encyclopedia of Space, by Jacqueline Mitton and Simeon Mitton; ISBN 0-590-59228-9

Science Dictionary of Space, by James Richardson (Troll Associates); ISBN 0-8167-2443-1

The Usborne Complete Book of Astronomy & Space, by Lisa Miles; ISBN 0746031041

Science Encyclopedia, (DK Publishing, Inc.); ISBN 0-7894-2190-9

Project Earth Science: Astronomy, by P. Sean Smith (National Science Teacher Association); ISBN 0-87355-108-7

The Moon Phases, by Gail Gibbons; ISBN 0-590-14905-9

Web sites

http://www.uen.org

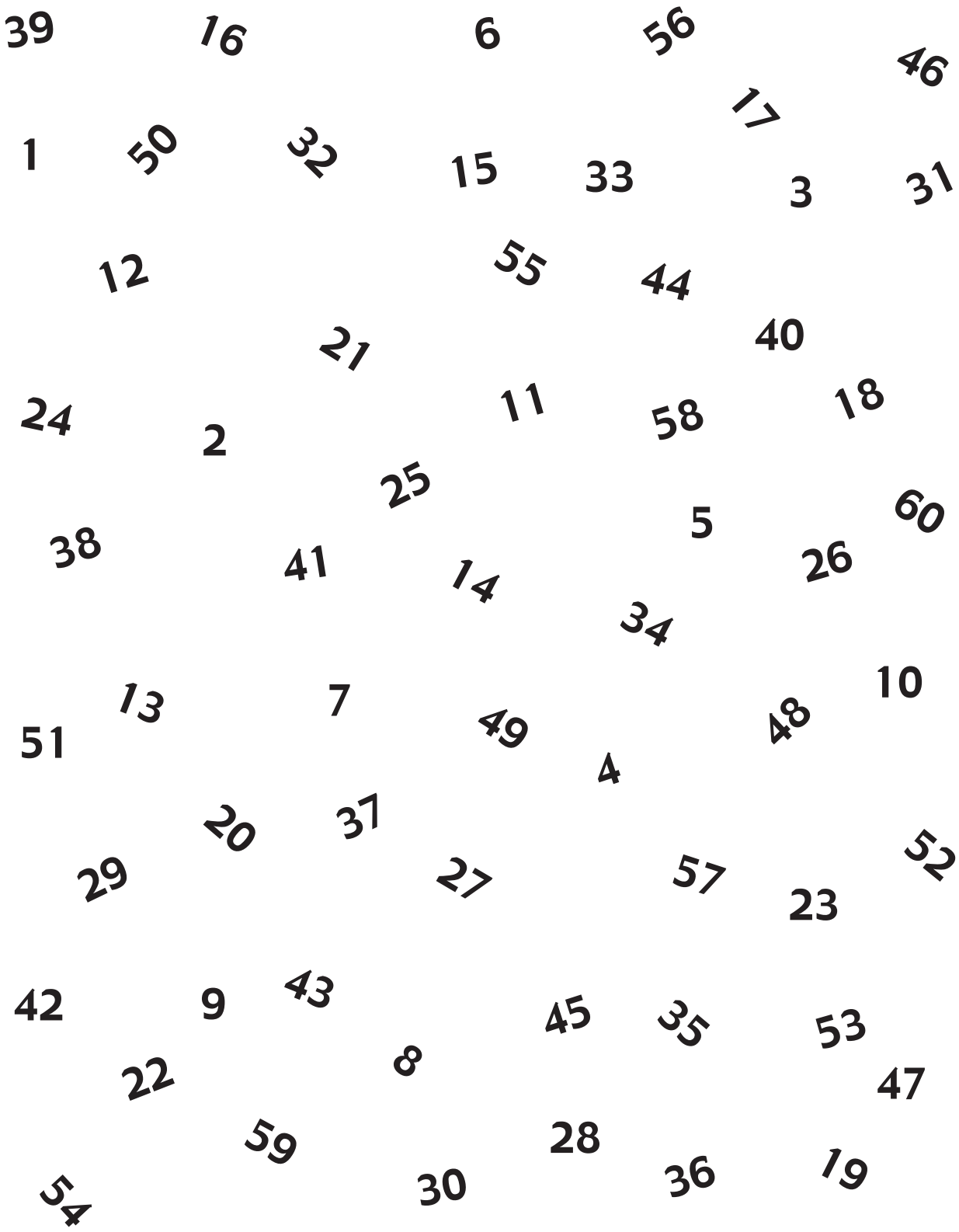
http://www.jsc.nasa.gov

http://images.jsc.nasa.gov

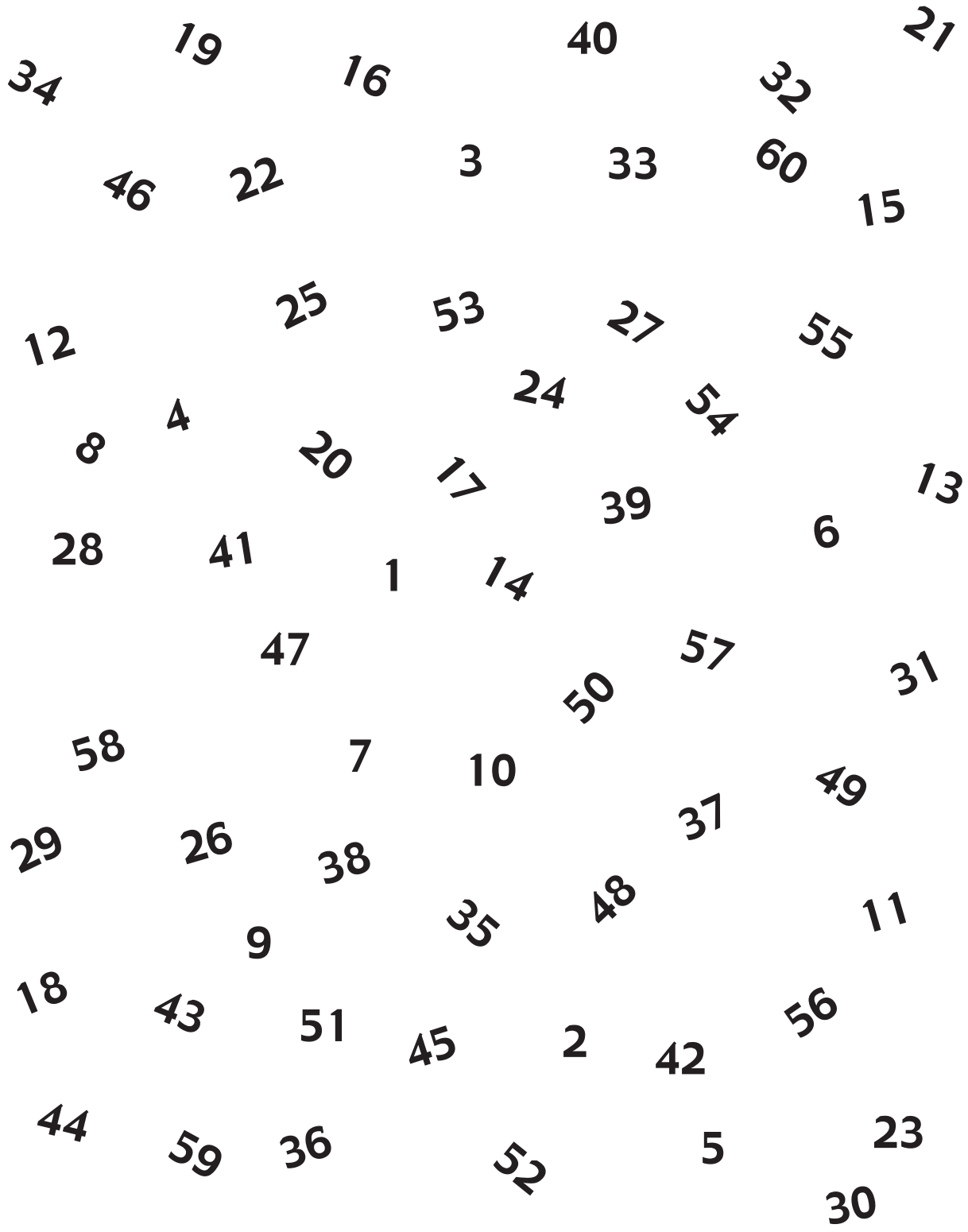
Family Connections

- Research careers in space exploration.
- Read and collect newspaper articles on moon phases.
- Write to NASA requesting information about the moon.

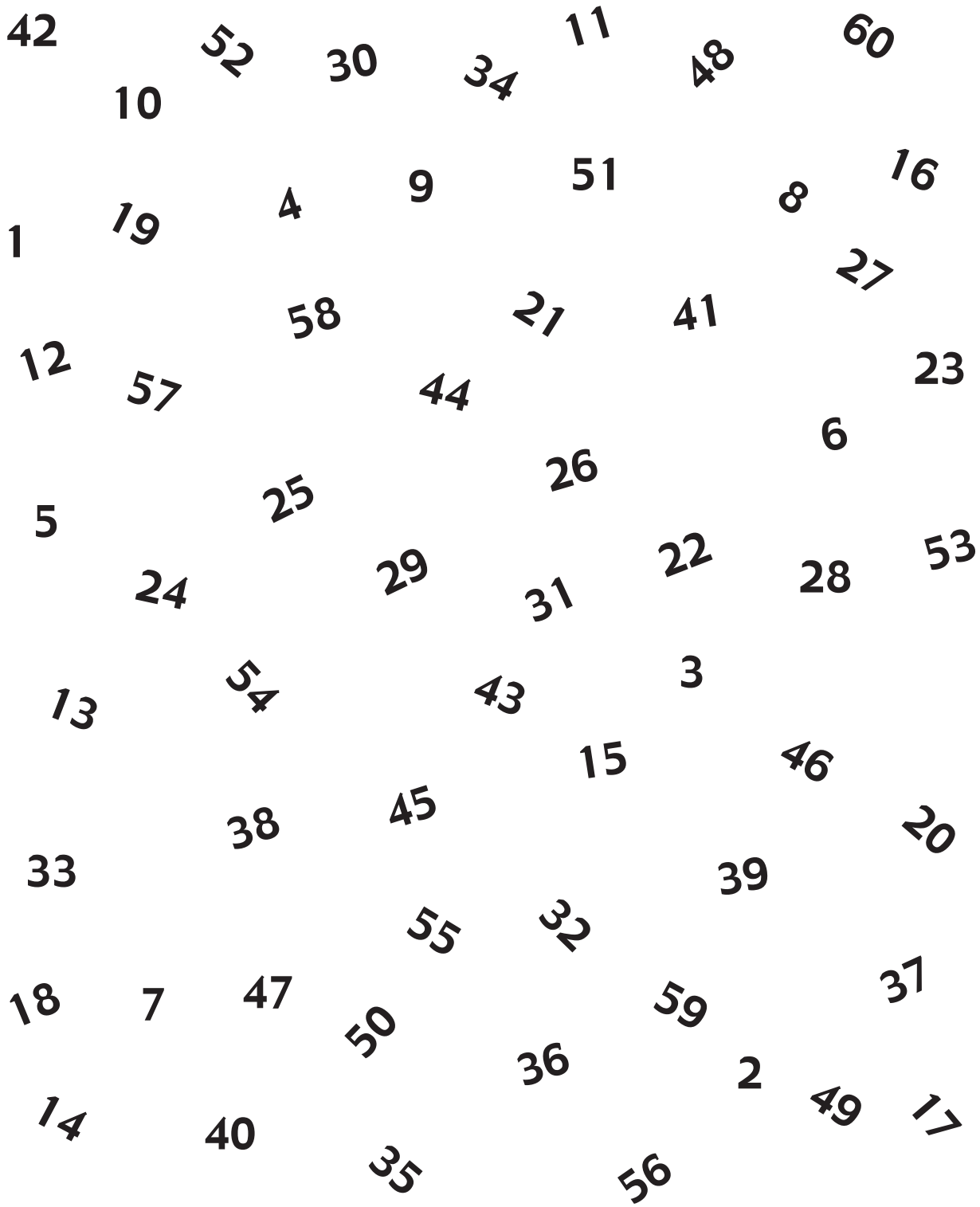
Consecutive Numbers #1

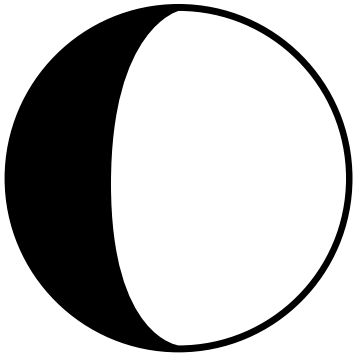
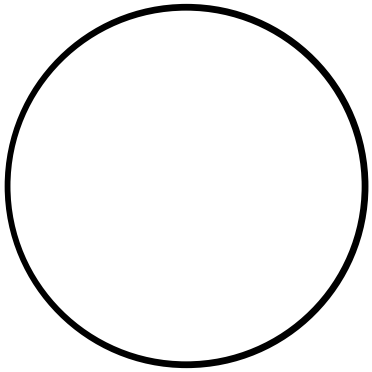
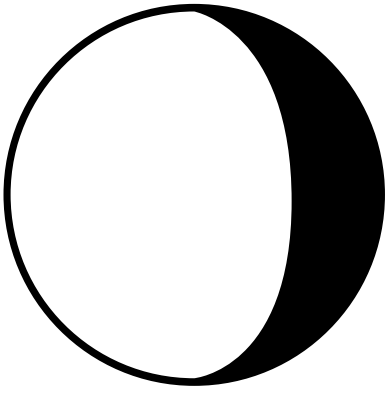


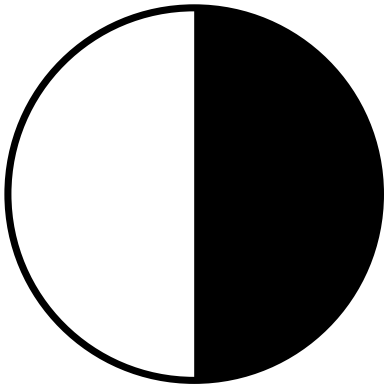
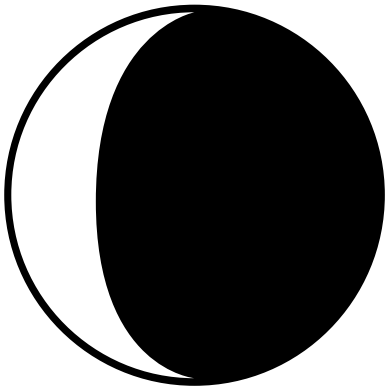
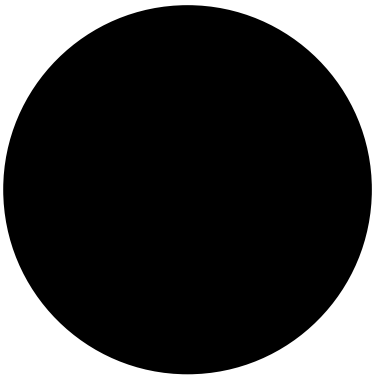
Consecutive Numbers #2

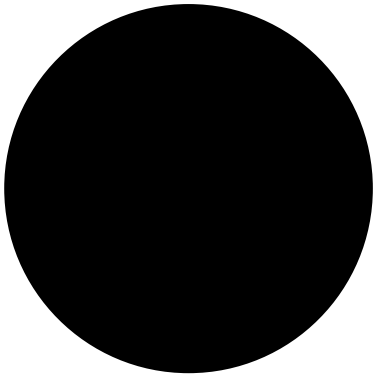
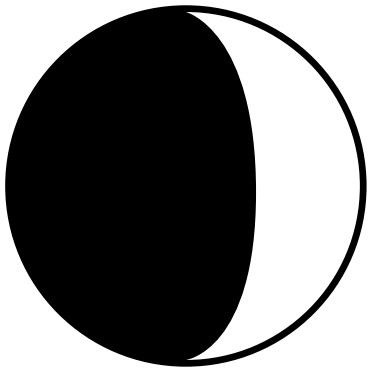
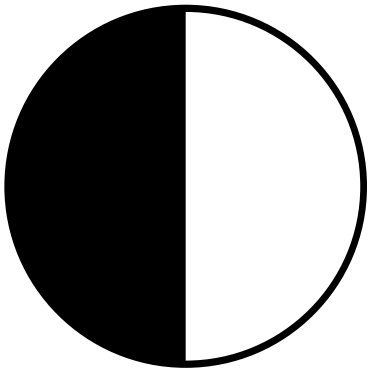


Consecutive Numbers #3

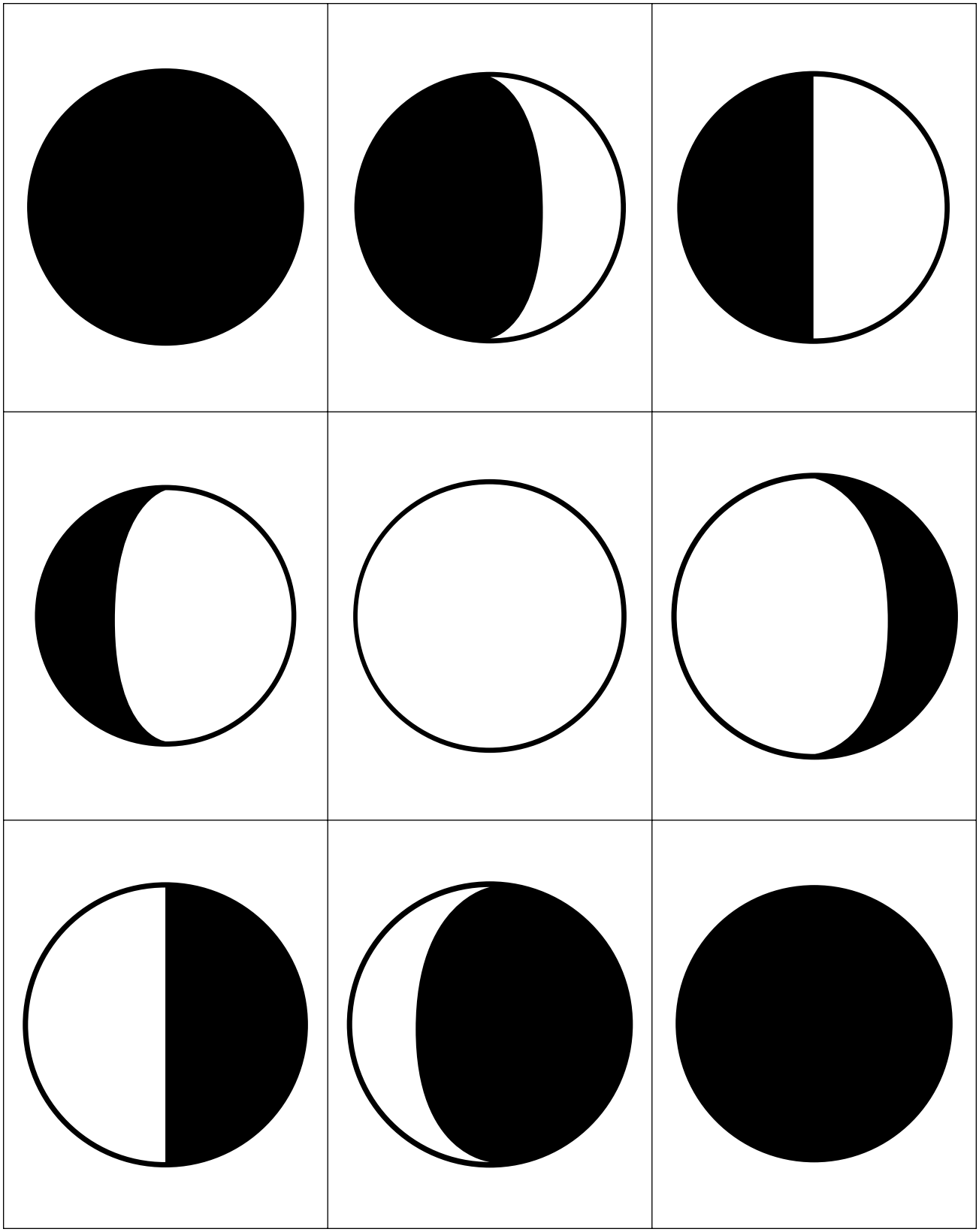


Moon Phase Cluster Word Cards	*Moon Phase Phrase Cards*	*Moon Phase Picture Cards*
Waxing Gibbous Moon	**The moon is waxing between a first quarter moon and a full moon.**	
Full Moon	**Two weeks have passed since the new moon. The entire face of the moon we see shines.**	
Waning Gibbous Moon	**The moon is between a full moon and a last quarter moon.**	

Last Quarter Moon	**The moon is three-quarters of its way around Earth. It is in its last quarter phase.**	
Waning Crescent Moon	**A bit of the waning sunlit side of the moon shows.**	
New Moon	**The moon is almost directly between the sun and Earth. (cycle starts again)**	

New Moon	**The moon is almost directly between the sun and Earth. (start of cycle)**	
Waxing Crescent Moon	**A bit of the sunlit side of the moon shows.**	
First Quarter Moon	**The moon is a quarter of its way around Earth. It is in its first quarter.**	

Moon Phase Cluster Word Pictures



Name _____

Drawing Moon Phases

Using the description and matching words, complete worksheet by adding the drawing of that phase of the moon.

Description:	**Drawing:**
1. **New Moon** Moon is almost directly between the sun and Earth. (start of cycle)	_____
2. **Waxing Crescent Moon** A bit of the sunlit side of the moon shows on the right side.	_____
3. **First Quarter Moon** The moon is a quarter of its way around Earth. It is in its first quarter phase.	_____
4. **Waxing Gibbous Moon** The moon is increasing in light between a first quarter moon and a full moon.	_____
5. **Full Moon** Two weeks have passed since the new moon. We see the entire face of the moon shining.	_____
6. **Waning Gibbous Moon** The moon is decreasing in light between a full moon and a last quarter moon.	_____
7. **Last Quarter Moon** The moon is three-quarters of its way around Earth. It is in its last quarter phase.	_____
8. **Waning Crescent Moon** A bit of the waning sunlit side of the moon shows on the left side.	_____
9. **New Moon** Moon is almost directly between the sun and Earth. (cycle starts again)	_____

Name _____

Matching Moon Phases

Read the description on the left and match it with the moon phase on the right. Please put the letter of the moon phase on the far left blank line and draw a line to the matching word.

Example:

1.__b__ The opposite of dark is

a. gold
b. light

1._____Moon is almost directly between the sun and Earth. (start of cycle)

2._____Moon is almost directly between the sun and Earth. (cycle starts again)

3._____A bit of the sunlit side of the moon shows, with the sunlit side being on the right.

4._____Two weeks have passed since the new moon. We see the entire face of the moon shining.

5._____The moon is three-quarters of its way around Earth.

6._____The moon is a quarter of its way around Earth.

7._____A bit of the sunlit side of the moon shows with the light side being on the left.

8._____The moon is between full moon and last quarter.

9._____The moon is increasing in light between a first quarter moon and a full moon.

10._____The moon is decreasing in light between a full moon and a last quarter moon.

a. Waning Gibbous Moon

b. Full Moon

c. New Moon

d. Waxing Crescent Moon

e. First Quarter Moon

f. Waning Crescent Moon

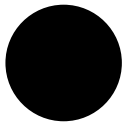
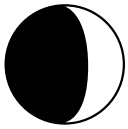
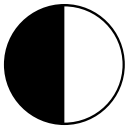
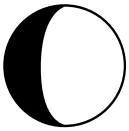
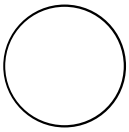
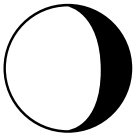
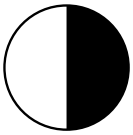
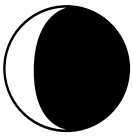
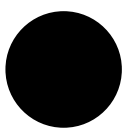
g. Last Quarter Moon

h. Waxing Gibbous Moon

i. Waning Gibbous Moon

j. New Moon

Cluster Word Answers

1. **New Moon** (start of cycle) Moon is almost directly between the sun and the Earth. Moon looks dark. We see no reflected light.	
2. **Waxing Crescent Moon** A bit of the sunlit side of the moon shows. It forms a crescent.	
3. **First Quarter Moon** The moon is a quarter of its way around the Earth. It is in its first quarter phase.We see it as half-lit. It is sometimes called a half-moon.	
4. **Waxing Gibbous Moon** The moon is waxing between a first quarter moon and a full moon. It is called a gibbous moon.	
5. **Full Moon** Two weeks have passed since the new moon. The entire face of the moon we see shines.	
6. **Waning Gibbous Moon** The moon is waning between a full moon and a last quarter moon. It is a gibbous moon.	
7. **Last Quarter Moon** The moon is three-quarters of its way around Earth. It is in its last quarter phase. We see it as half-lit. It is sometimes called a half-moon.	
8. **Waning Crescent Moon** A bit of the sunlit side of the moon shows. It forms a crescent. We see a small sliver of the moon.	
9. **New Moon** (cycle starts again) Moon is almost directly between the sun and the Earth. Moon looks dark. We see no reflected light.	

Lunar Language

Science Standard I

Objective 1

Connections

Science Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits Earth.

Intended Learning Outcomes:
2. Manifest Scientific Attitudes and Interests
4. Communicate Effectively Using Science Language and Reasoning
6. Understand the Nature of Science

Content Connections:
Language Arts I-1, IV, VI-1, 2, 3, VII-1, 2, 3, VIII-1, 2, 3, 4

Background Information

Compared with the other moons in the solar system, Earth's moon is something of an oddity. Most of the planets in the solar system have much smaller moons, however, Earth's moon is about four times smaller than Earth. The moon is the only natural satellite of Earth and is the second brightest object in the sky. However, its light is only a reflection from the sun.

As a satellite, the moon revolves around Earth. The moon actually takes 27 1/3 days to orbit Earth. This time is known as a *sidereal month*. However, it takes 29 1/2 days for a complete cycle of the moon phases to occur, when measured from new moon to new moon. This period is known as the *synodic*, or *lunar month*.

At the *new moon* phase, the moon is between Earth and sun, creating a situation where no light is reflected from the side facing Earth. In other words, the moon is between Earth and the sun.

The half-lit side of the moon, or *first quarter*, is when the moon is highest in the sky at sunset. During the *full moon*, the moon is behind Earth, with Earth being closest to the sun.

Materials

- ❑ One Lego design preconstructed for display
- ❑ One set of Legos (same model as above) for each student
- ❑ File folder or test cover for each student

Invitation to Learn

1. Create and show the pre-constructed Lego design for two minutes, then put it away.
2. Give each student the exact color and number of Legos as used in the design shown in step one.
3. Distribute a folder to cover each student's working area.
4. Ask each student to recreate the design you just showed, keeping their design covered while they work.

5. After each student has completed his/her design, ask students to show their designs at the same time.
6. See which design most closely matches yours and discuss why it is close to yours.
7. Discuss how it could have been easier for students to recreate teacher's design.
8. Explain that if students could have taken notes or drawn a picture they could have recreated the teacher's design exactly.
9. If time permits, allow students to take notes and draw a picture of your design as you show it again for the same amount of time.
10. Discuss why it was easier this time.
11. The purpose of today's activity is to recognize the importance of using the tools of *observation* and *recording*.

Instructional Procedures

Materials

- ❑ Lesson from the TRB 6:1-Activity 1 *It's Just a Phase*
- ❑ Materials from *It's Just A Phase*
- ❑ *Lunar Language Graphic Organizer*

1. Repeat the lesson from the TRB 6:1 Activity 1-*It's Just a Phase*.

   Pause after each of the major phases.

   - The four major phases of the moon are *new moon*, *first quarter, last quarter,* and *full moon*.
   - The other phases are optional and not required in the state Core Curriculum. If time permits, these other phases are great extensions.

2. Use the *Lunar Language Graphic Organizer* (p. 5-22) to:
   a. Draw what you see in the smaller box labeled 'draw.'
   b. Describe what you see in the box below, labeled 'description.'
      - Be sure you have had previous lessons on descriptive language and the importance of word choice.
      - You can give your students hints on how to help describe these phases. Encourage them to use qualitative (five senses) and quantitative (numerical) research.
   c. Repeat this process for the next three major phases from new moon, to first quarter, full moon, and last quarter, until the graphic organizer is complete.
3. Using the same graphic organizer, model on the overhead how student graphic organizers should look. Be sure to model descriptive language and the names of the phases of the moon.

- Ask for feedback and hints from students to add to this list.
- Each student can add to his/her graphic organizer as you discuss each box or phase.
- Students may keep this organizer, or you may collect them for the next activity.

Possible Extensions/Adaptations/Integration

Materials

For each student:

- ❑ *All About the Moon*
- ❑ *ABC Moon Words* worksheet

ABC Moon Words

Note: This activity can be used before, during, and after reading.

Before reading: Students insert words reflecting prior knowledge on the moon.

During reading: Students record words and phrases they believe are important to the moon.

After reading: Students add new words they consider important to their chart.

1. Distribute materials to each student.
2. Have students read *All About the Moon*. As they are reading, have them complete the *ABC Moon Words* worksheet (p. 5-23) by writing a meaningful "moon" word in each box. If at all possible, have students write a word in each box. This activity should only last five to eight minutes. Some students may not have a word in each letter box—this is okay.
3. Have the students pair up and share some of their answers for each box. Next, have the entire table share some of their favorite words.
   - The *ABC Moon Words* worksheet may be used in the following additional ways:
     - As a video guide.
     - Final for a book report.
     - Picture book as you are reading.
     - Mini book.
     - Like a mini word wall.
     - Individual student dictionary card.
4. Draw imaginary faces of the moon and write a paragraph of the profession of your moon character. See *Kids Discover Magazine—Moon*, page 18 "Who's In the Moon."

Assessment Suggestions

- Assessment for this activity takes place when students use the graphic organizer to write a sequential paragraph.
- Students may also create their own moon phases flip book, great examples are in *Astronomy Adventures* (Ranger Rick's Nature Scope) or Discovery Channel School worksheet 1 Lunar Phase Flip Book (see *Additional Resources*).
- Create printmaking phases of the moon using Styrofoam plates, showing positive and negative space.
- Create a mural using paper plates and models that demonstrate phases of the moon.

Additional Resources

Books

*Astronomy Adventures (*Ranger Rick's Nature Scope, National Wildlife Federation); ISBN 0-07-046509-6

Can You Hear a Scout in Space?, by Melvin and Gilda Berger (Scholastic); ISBN 0-439-09583-2

The Usborne Complete Book of Astronomy & Space, by Lisa Miles; ISBN 0746031041

All About the Moon, by Wes Lipschutz; ISBN 0823937429

Web sites

http://school.discovery.com

http://school.discovery.com/lessonplans/worksheets/lightofthemoon/worksheet1.html

Family Connections

- Expand student knowledge by writing or researching the origin of the moon.
- Create a paper plate mural of moon phases from drawings created in this activity.
- Create a papier-mâché model of each of the phases.

Lunar Language Graphic Organizer

Lunar Language Graphic	Lunar Language Graphic	Lunar Language Graphic
Draw:	**Draw:**	**Draw:**
Description:	**Description:**	**Description:**

Name _____

ABC Moon Words

A	**B**	**C**	**D**
E	**F**	**G**	**H**
I	**J**	**K**	**L**
M	**N**	**O**	**P**
Q	**R**	**S**	**T**
U	**V**	**W**	**X Y Z**

Patterned Paragraphs

Science Standard I

Objective 1

Connections

Science Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits Earth.

Intended Learning Outcomes:
1. Use Scientific Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
4. Communicate Effectively using Scientific Language and Reasoning

Content Connections:
Language Arts I-1, IV-3, VI-1, 2, 3, VII-1, 2, 3, VIII-1, 2, 3, 4, 6

Background Information

The brightest object in the night sky is the moon—Earth's only natural satellite. It is also our closest neighbor, being 384,400 kilometers away from Earth. As you look at the moon you may notice that its features appear clean and distinct. This is because the moon has no atmosphere to distort your view.

When you see the moon in the night sky it appears round sometimes; other times it appears as a half-moon or a crescent shape. These different shapes are called *phases*. The positions of the moon, Earth, and the sun cause the phases of the moon, eclipses, and tides.

Because the sun lights the moon, half of the moon is always in the sunlight (except during a lunar eclipse). Since the moon revolves around Earth, we see the moon from different angles. The part of the moon that faces Earth is not always the half-lit side. The phase of the moon you see depends on how much of the illuminated side of the moon faces Earth on that day.

See *Phases of the Moon* (p. 5-29) for further understanding and clarification.

Materials

- ❑ Loaf of bread
- ❑ Peanut butter (small jar)
- ❑ Jam (small jar any flavor)
- ❑ Butter knife
- ❑ Table cloth
- ❑ Damp rag to use and clean with

Invitation to Learn

The objective of this activity is to reinforce the importance of being specific while dealing with events of a sequential nature.

Preparation: Place a table cloth on a table and set out all the materials.

1. Choose a student to give you instructions on how to make a sandwich.

2. Have the student come to the front of the room.
3. Have that student stand with his/her back to you (about three feet away).
4. Explain the rules for this activity.
   - Student can not turn around until you say so.
   - After s/he gives you an instruction, you will say, "Okay," then s/he can go on to the next step.
5. Have the student give you instructions on how to make a peanut butter and jelly sandwich.
6. As you follow the student's instructions, be very literal in following the directions you are given (e.g., If told to open the bread—rip it open [rarely will they tell you to untwist the tie]. If you are instructed to stick the knife in the peanut butter—stick in upside down [rarely will they tell you to put the pointed tip in].).

   In other words, really ham it up, make a mess, and have nothing that resembles a sandwich at the end.
7. The focus is for students to realize how important it is to give specific and detailed instructions.
8. Have each student write specific and detailed instructions on how to make a peanut butter sandwich if time permits.

Instructional Procedures

1. Model for the class how to write a paper on *How to Make a Peanut Butter Sandwich*. Read steps three and four below and make sure you incorporate them into your example.
2. Using the *Lunar Language Graphic Organizer* (p. 5-22) as a reference, have students write a paragraph describing the phases of the moon.
3. Give exact expectations required for this piece of work. Example:

   Introduction

   Supporting paragraph #1
   - May include full moon, waxing gibbous, and first quarter.

   Supporting paragraph #2
   - May include waxing crescent and new moon.

   Supporting paragraph #3

Materials

- ❏ *Lunar Language Graphic Organizer*
- ❏ Chart text clue words used to connect and link or sequence words, you could also use compare and contrast words. Have these words on overhead, poster, word wall etc.
- ❏ Colored markers
- ❏ Writing paper for each student

- May include waning crescent and last quarter.

Supporting paragraph #4

- Could include waning gibbous back to full moon.

Conclusion

Ensure the grading rubric coincides with the stated requirements.

Hints and Suggestions

- To ensure that the text clues for sequence are set off, you may want to use the following color-coded system:
  - Introductory paragraph (green)
  - Linking or sequence words (purple)
  - Supporting paragraphs (black)
  - Concluding paragraph (red)
- Have a list of sequence words and compare/contrast words for student reference. These may be in their journals, table helpers, word walls, or any place where they can see and use them.
- Some text clues for *sequence* are: first, second, third, now, later, before, after, then, next, finally, following, while, meanwhile, last, during, not long, when, on (date), at (time), in conclusion, until, lastly.
- Some text clues for *compare/contrast* are: in like manner, likewise, similarly, the difference between, as opposed to, after all, however, and yet, but, nevertheless, different from, same as, alike, similar to, unlike, but, yet, as well as, either...or, not only...but also, compared to, in contrast, while, resembles, although, unless.

4. Show various types of instructions for students to view—anything that helps them write a sequence paper (e.g., bicycle instructions, computer instructions, etc.).
5. When the paper is in rough draft form, have the student read it out loud to catch fluency, word choice, and convention mistakes.
6. Next, have them explore various types of text to check for content accuracy and add anything necessary.
7. Have students share with a partner, looking for fluency mistakes and checking for understanding. Look for any convention errors and edit properly.
8. If time permits and it has been modeled, have students do peer

editing.

9. After all corrections have been checked, have students choose a format for publishing. Some ideas for publishing are:
   - Step books
   - Pop-up books
   - Mini-books
   - Film-strip
   - Story in a Can
   - Science in a Window
   - Accordion Books
   - Diary

Possible Extensions/Adaptations/Integration

- Have students draw a diagram replicating the phases of the moon, showing relative positions of Earth, moon, and sun.
- Have students draw the phases of the moon every other night as seen from their backyard. What clues show that the phases of the moon are changing?
- Have students write three critical-thinking questions about the moon in their science journals.
- Have the students write poetry about the moon. See *Moon-Whales and Other Poems* for ideas.
- Have students use a dictionary to find other words formed from "luna."
- Have students write moon myths.

Art

- Have students draw a "Person in the Moon" using all characteristics of the moon's surface and labeling each feature. Use *Kids Discover Magazine—Moon* as a source.

Assessment Suggestions

- You may chose to use the "Six Traits" of writing and grade on one section at a time (i.e., ideas, organization, voice, word choice, sentence fluency, or conventions)
- Organization is an excellent assessment strategy.

Additional Resources

Books

Nonfiction Matters, by Stephanie Harvey; ISBN 1-57110-072-5

The Big Book of Reproducible Graphic Organizers, by Jennifer Jacobson (Scholastic); ISBN 0-590-37884-8

Books Don't Have to Be Flat, by Kathy Pike (Scholastic); ISBN 0-590-12049-2

Scholastic Encyclopedia of Space, by Jacqueline Mitton and Simeon Mitton; ISBN 0-590-59228-9

Project Earth Science: Astronomy, by P. Sean Smith (National Science Teacher Association); ISBN 0-87355-108-7

Quick and Creative Reading Response Activities, by Jane Fowler (Scholastic); ISBN 0-439-09845-9

The Moon, by Seymour Simon; ISBN 0-02-782840-9

Moon-Whales and Other Poems, by Ted Huges; ISBN 0-670-48864-X

Magazines

AIMS Magazine, January 1994, p. 39

Kids Discover Magazine—Moon

Web sites

http://www.graphic.org

http://www.kcmetro.cc.mo.us/maplewoods/writeplace.organization.html

http://www.writedesignonline.com/organizers/

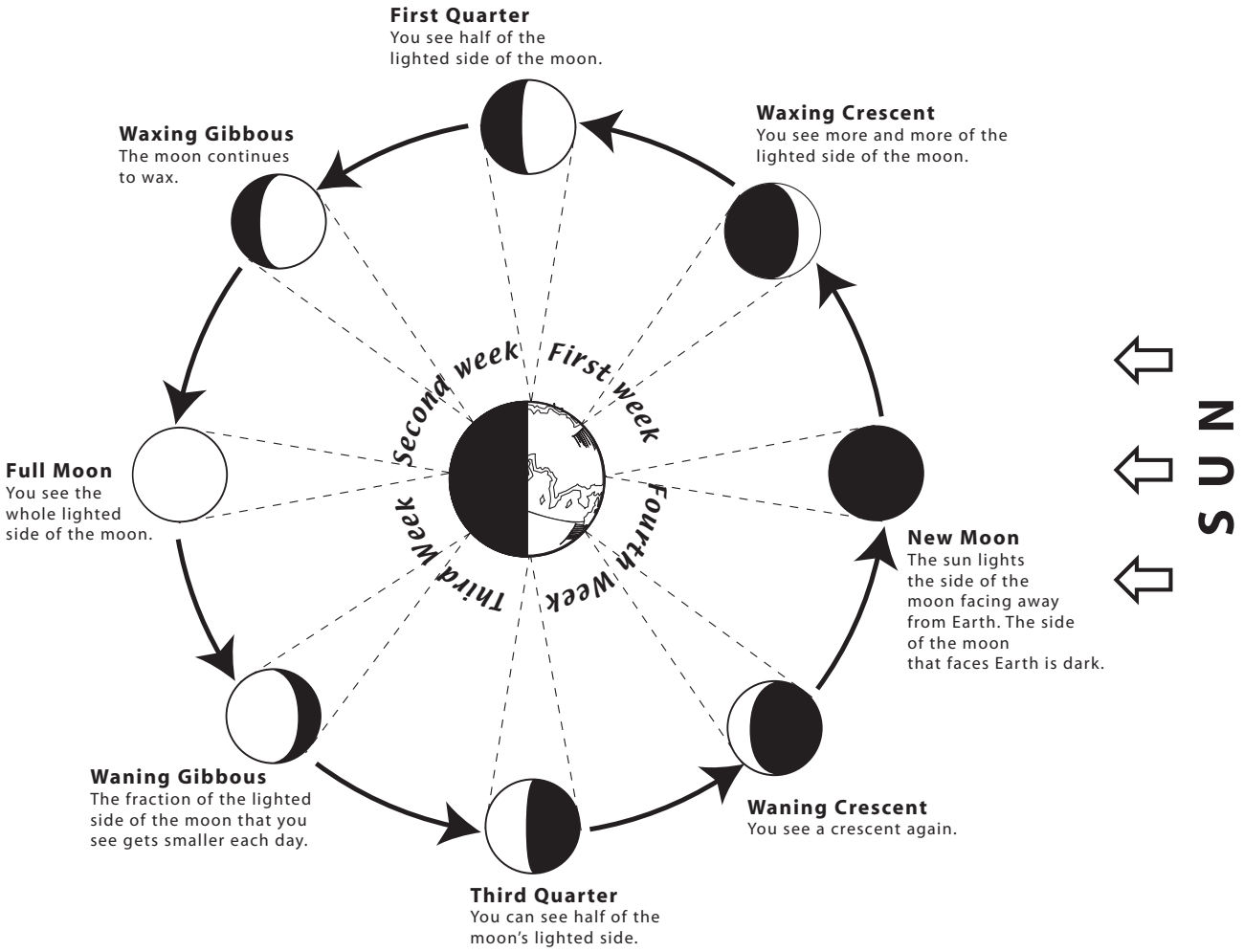
http://www.ncrel.org/sdrs/areas.issues/students/learning/lr!grorg.html

Family Connections

- *Moon Phase Cluster Word, Phrase, and Picture Cards*—matching picture to word
- ABC Books
- Film Strips Books
- Diary of a Scientist (Galileo)

Phases of the Moon

The diagram below shows a view of Earth and the moon phases from above. The sun is shining from the right. The outer ring of photos shows the different amounts of the sunlit side of the moon that an observer on Earth sees as the moon revolves around Earth.



(As viewed from Earth)

Sixth Grade Science Content Checklist

Standard I: **Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.**

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

- ❑ Explain patterns of changes in the appearance of the moon as it orbits Earth.
- ❑ *I know why the moon looks different on different nights.*

- ❑ Describe changes in the appearance of the moon during a month.
- ❑ *I can make a drawing of how the moon will look each night over a month.*

- ❑ Identify the pattern of change in the moon's appearance.
- ❑ *If you show me a picture of the moon I can make a good guess at what it will look like in two weeks.*

- ❑ Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
- ❑ *If I give you a picture of the horizon, where will the moon be in June and where will it be in December?*

- ❑ Design an investigation, construct a chart, and collect data depicting the phases of the moon.
- ❑ *I can design a method of gathering data that will show how the moon changes phases.*

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

- ❑ Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
- ❑ *I know the difference between an object that is spinning and an object that is going in big circles.*

- ❑ Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.

- ❑ Model the movement and relative positions of Earth, the moon, and the sun.
- ❑ *I can use regular items (like balls) to show how close the Earth, moon, and sun are to each other and how they move.*

Science Standard II Activities

Notes on the Seasons

Science Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1:
Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles

Content Connections:
Language Arts I-1, VI-1

Science Standard II

Objectives 1 & 2

Connections

Background Information

The reason why we have seasons is one of the toughest concepts for students to grasp. It is far easier to believe the misconception that we have seasons because we are closer to the sun in the summer and further away in the winter. This is actually false, we are further away in the summer and closer in the winter. Also, this does not explain why we have winter when the southern hemisphere has summer. Helping students to overcome this misconception can be quite difficult.

The purpose of the guided notes is two fold. First, it is a way of teaching students to take notes. Second, it is a tool to help students review for a test. Guided notes can be used in the classroom with each unit of study. They can be stored until the end of the year when they are pulled out and used as a means to review for the end-of-level test. Guided notes are teacher-prepared handouts that follow what you are going to teach. They are easy to make, you simply write down the things that you feel are most important for students to know and are identified in the Core Curriculum. After you have done this, you decide key words that you want students to focus on. These words are deleted and a blank space is put in their place. The student fills in these blanks as the teacher goes over the notes.

Invitation to Learn

Guided notes rarely take the whole period, so this is a great time to review the vocabulary that is at the end of each section of the Core Curriculum. Flashcards, while old fashioned, are still a good way to

introduce, learn, and use science language. The cards can be laminated and placed on a ring for easy storage. Introduce each word by reading it and the definition, then have students repeat them with you. Review five to eight words a day. Students have one minute to go through the cards as quickly as they can. As soon as they think they can pass off all the words in under one minute, they come to you and try. Show them the definition side; they have to read the definition and say the word for all the words in the set in under one minute. If they are able to do that, they are able to pass off other students, helping them to continue reviewing the words.

Instructional Procedures

Materials

- ❑ *Guided Notes—Seasons* handout
- ❑ Overhead projector
- ❑ *Guided Notes—Seasons* overhead transparency
- ❑ *Seasons Vocabulary Cards*
- ❑ Globe
- ❑ North Star

1. Give each student a *Guided Notes—Seasons* handout (p. 6-6).
2. Place the *Guided Notes—Seasons* overhead on the projector and turn it on. This serves as a guide for you. In classes where the students can keep up, **do not** fill in the blanks; simply repeat and have the students repeat the words in the blanks. Write in the words to accommodate students with special needs or those who are English language learners.
3. Guided notes are easy to do. You simply read the sentence, fillling in the blanks. Students write the words that go in the blanks on their handouts. Repeat the sentence, having students say the words that go in the blanks.
4. As you teach the notes, demonstrate the different concepts. For example, when you talk about the North Star, take a globe and point the axis towards the North Star that you have placed somewhere in your room earlier (preferably on the ceiling or upper portion of the north side of the classroom). Pick a student or object to represent the sun. Revolve around that object while keeping Earth's axis pointing toward the North Star.
5. As you complete the notes, periodically review previous concepts covered, especially if they pertain to what you are currently talking about.

Assessment Suggestions

- Have students review their notes periodically.
- As a quiz, hand out a copy of the notes for students to fill in the blanks.
- Use the notes to write multiple choice and short answer questions for tests.

Additional Resources

http://www.interventioncentral.org/htmdocs/interventions/study/gnotes.shtml#topAnchor

http://www.acs.ohio-state.edu/grants/dpg/fastfact/notes.html

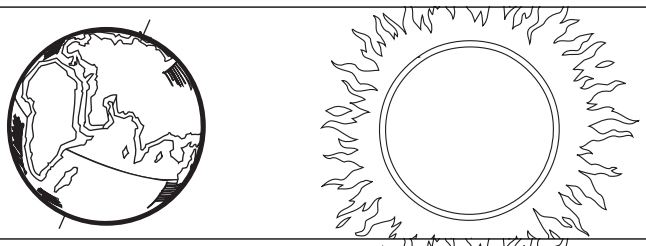
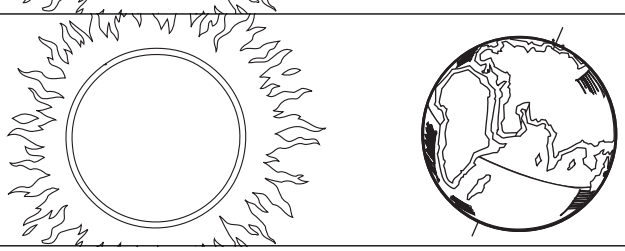
http://www.studygs.net/guidednotes.htm

Name _____

Guided Notes–Seasons

1. Earth _____ around the _____ in a path that _____ itself every _____.
2. This path is called an _____.
3. Earth's _____ is not straight _____ and _____ but _____ at an angle of _____.
4. The _____ _____ is almost directly above the _____ Pole. Because of this the _____ _____ always stays in the _____ _____ in the sky. _____ the other _____ seem to revolve around the _____ _____.
5. This means that Earth's _____ _____ _____ always points in the _____ _____ while it revolves around the sun.
6. Because of this the _____ hemisphere is tilted towards the sun around the _____. The _____ hemisphere is tilted towards the sun about the _____.
7. When the Northern hemisphere has _____ the southern hemisphere has _____. When the northern hemisphere has _____ the southern hemisphere has _____.
8. When the northern hemisphere is tilted _____ from the sun in _____, the _____ appears _____ in the sky. The angle of the _____ hitting Earth is _____. This means that the northern hemisphere receives _____ _____ from the sun.
9. When the northern hemisphere is tilted _____ the sun in _____, the _____ appears _____ in the sky. The angle of the _____ hitting Earth is _____. This means that the northern hemisphere receives _____ _____ from the sun.
10. In summer the sun is _____ _____ and the _____ are _____. This gives the sun plenty of time to _____ Earth.
11. In the winter the sun is _____ _____ and the _____ are _____. This gives the sun little time to _____ Earth.
12. The two reasons that we have seasons are:
    1._____
    2._____

In the diagram below, label the picture that shows when it is summer in Utah, "Summer;" and the picture that shows when it is winter in Utah, "Winter."

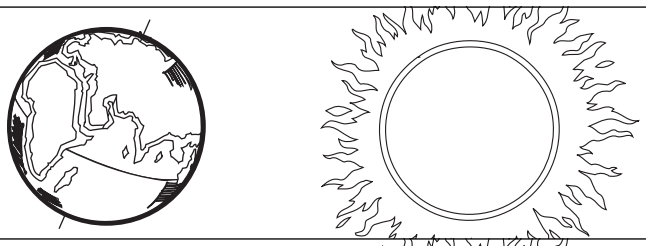
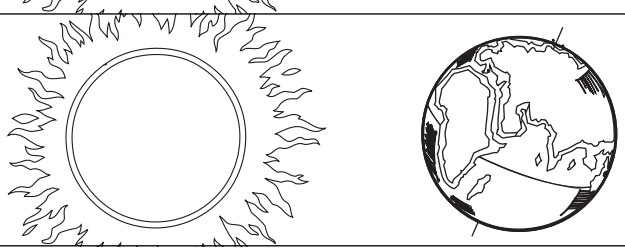
Example A _____	
Example B _____	

Name _____

Guided Notes–Seasons

1. Earth _revolves_ around the _sun_ in a path that _repeats_ itself every _year_.
2. This path is called an _orbit_.
3. Earth's _axis_ is not straight _up_ and _down_ but _tilted_ at an angle of _23.5°_.
4. The _North Star_ is almost directly above the _North_ Pole. Because of this the _North Star_ always stays in the _same place_ in the sky. _All_ the other _stars_ seem to revolve around the _North Star_.
5. This means that Earth's _axis of rotation_ always points in the _same direction_ while it revolves around the sun.
6. Because of this the _northern_ hemisphere is tilted towards the sun around the _21st of June_. The _southern_ hemisphere is tilted towards the sun about the _21st of December_.
7. When the Northern hemisphere has _summer_ the southern hemisphere has _winter_. When the northern hemisphere has _spring_ the southern hemisphere has _fall_.
8. When the northern hemisphere is tilted _away_ from the sun in _December_, the _sun_ appears _low_ in the sky. The angle of the _sunlight_ hitting Earth is _low_. This means that the northern hemisphere receives _little energy_ from the sun.
9. When the northern hemisphere is tilted _toward_ the sun in _June_, the _sun_ appears _high_ in the sky. The angle of the _sunlight_ hitting Earth is _high_. This means that the northern hemisphere receives _more energy_ from the sun.
10. In summer the sun is _high overhead_ and the _days_ are _longer_. This gives the sun plenty of time to _heat_ Earth.
11. In the winter the sun is _low overhead_ and the _days_ are _shorter_. This gives the sun little time to _heat_ Earth.
12. The two reasons that we have seasons are:
    1. _The Earth is tilted_
    2. _The Earth moves around the sun_

In the diagram below, label the picture that shows when it is summer in Utah, "Summer;" and the picture that shows when it is winter in Utah, "Winter."

Example A Summer	
Example B Winter	

Seasons Vocabulary Cards

1. An imaginary line going from the north pole to the south pole. Earth spins on this line.	2. Earth's axis is not straight up and down, instead it leans at a 23.5° angle	3. The path that a planet travels as it goes around the sun.	4. The changes in the appearance of the moon's shape during a month.
5. We see all of the lit side of the moon. Earth is between the sun and the moon.	6. The moon has moved one-quarter of the way around Earth.	7. We cannot see the moon. The moon is between Earth and the sun.	8. The moon has moved three quarters of the way around Earth.
9. The bouncing of light off of an object. The moon appears to shine because of the sun's light.	10. The circling of one object around another object in space. A planet moves around the sun. A moon orbits around a planet.	11. When a planet or moon spins on its axis.	12. Due to the tilt of Earth as it travels around the sun, we have spring, summer, fall, and winter.

4. Phases of the moon	8. Last quarter	12. seasons	
3. Orbit	7. New moon	11. Rotation	
2. Earth's tilt	6. First quarter	10. Revolution	
1. Axis of rotation	5. Full moon	9. Reflection	

Why Angle Changes Intensity

Science Standard II

Objectives 1 & 2

Connections

Science Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1:
Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts I-1, VII-1; Math III-2, V-1

Background Information

There are two ways Earth's tilt causes seasons. The first is that there are more daylight hours when we are tilted toward the sun in summer, and fewer in the winter when we are tilted away. The second reason is that when the sun is high overhead, we receive more direct sunlight; in the winter the opposite is true. Therefore, the reason that summer is hotter than winter is two-fold. First, the days are longer, so the sun has longer to heat Earth. Second, the sun's rays are more directly overhead, delivering more heat to Earth.

Invitation to Learn

Ask students why they think we have seasons. Many will say because we are closer to the sun in summer than in winter. To help overcome this misconception, tell students that we are actually closest to the sun in January. Then tell them that there is a space heater at the back of the classroom. Imagine you are really cold and want to get warmer. Ask for suggestions on how to get warmer. They will probably tell you that they need to get closer to the heater. Take a baby step forward and ask if this will help warm you up. They say no. Point out that the difference between Earth's farthest distance from the sun and its closest is comparable to that baby step. Therefore, Earth's distance from the sun plays a very small role in its temperature variation.

Instructional Procedures

1. Cut the *Centimeter Grid* transparency (p. 6-15) so that it will cover the flashlight with a little overlap. Tape the transparency over the lens of the flashlight.
2. Place the flashlight so that it is parallel to the floor and perpendicular to the wall; turn it on.
3. Ask students what the grid looks like. Are all the grids the same size? If some are smaller, which ones?
4. Tilt a poster board at a 45˚ angle to demonstrate the tilt of Earth.
5. Ask students how the gridlines have changed. Are all the grids the same size? Which ones are larger? Which ones are smaller? Why do you think they changed? If each square has the same amount of heat, which squares do you think will get the hottest? Why? Which ones will not heat up as quickly? Why?
6. Have the students try this on their own in groups of three to four. Have them tape a piece of graph paper to a piece of cardboard or on a clipboard.
7. Give each group a flashlight. Have them place the flashlight on a pile of books so that the flashlight is parallel to the floor.
8. Place the graph paper so that it is perpendicular to the flashlight about 1 1/2 to 2 feet away (if you have mirror stands, they help keep the cardboard upright). Aim the flashlight at the graph paper then turn it on.
9. Have students trace the area illuminated by the flashlight.
10. Have students change the angle of the cardboard so that it is leaning back away from the flashlight at an angle of 23.5˚. Have students trace the new area illuminated by the flashlight in a different color.
11. Have students change the angle again to 45˚ or 60˚ and trace the illuminated area in a different color.
12. Make sure that students keep the flashlights at exactly the same distance from the cardboard throughout the activity.

Materials

- ❏ Flashlight
- ❏ *Centimeter Grid* overhead transparency
- ❏ *Centimeter Grid* paper
- ❏ Darkened room (Taping black paper over the windows helps.)
- ❏ Piece of cardboard or clipboard
- ❏ Clear tape
- ❏ Markers
- ❏ Protractors

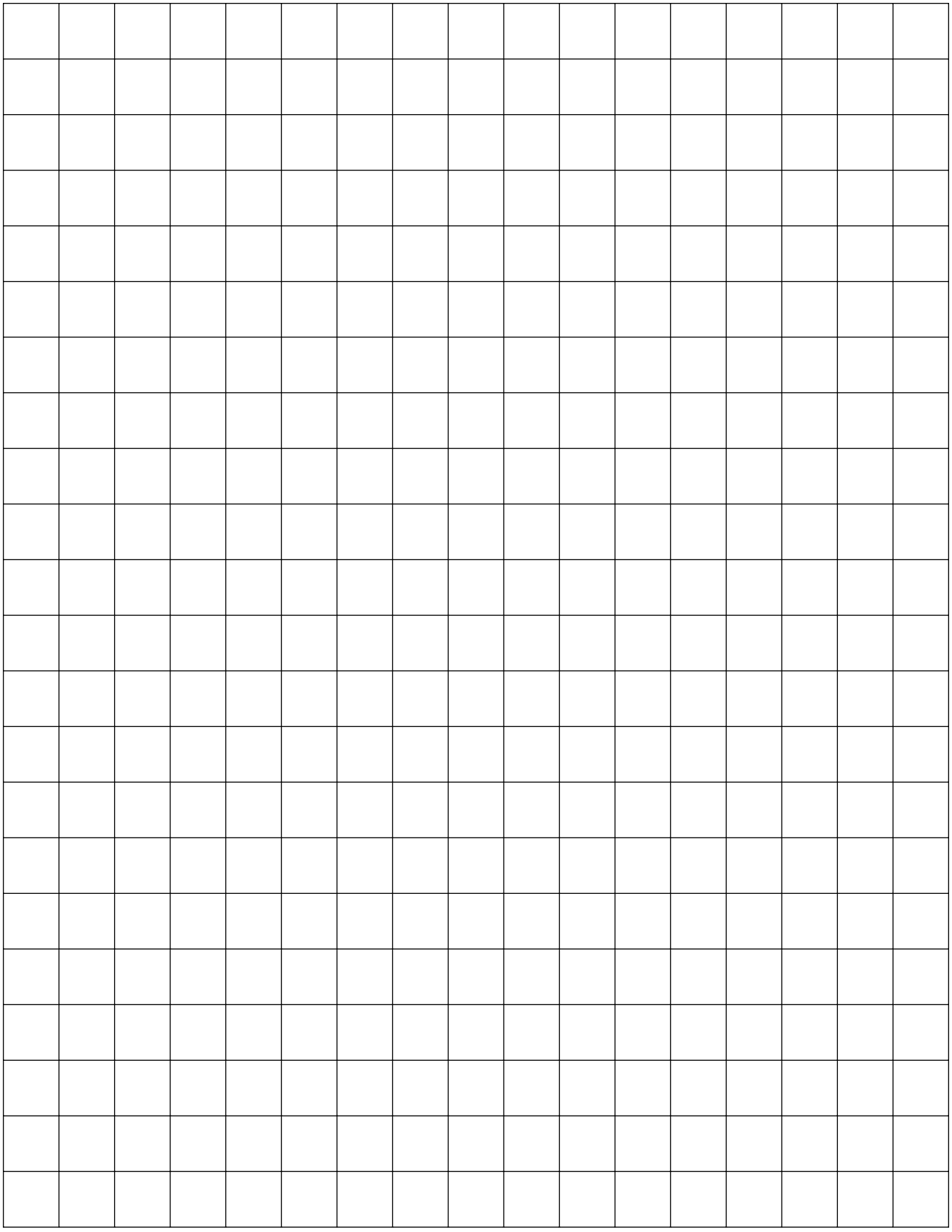
Assessment Suggestions

Students may answer the following questions individually, in groups, or as a whole class:

- Does the quantity of heat in the flashlight change as you change the angle?
- Of the three angles you tried, which one will heat up the cardboard the most?
- Why do you think that one angle will heat up the cardboard more than another?

Note to teachers: No matter what the angle is, the amount of light energy from the flashlight remains the same. Therefore, the greater the angle, the less intense the light energy on each square will be and it will not heat up as much, due to the angle increasing the size of the square, while the amount of light remains consistent.

Centimeter Grid



Tracking Sunrise and Sunset

Science Standard II

Objective 2

Connections

Science Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts I-1, VI-1; Math III-2, V-1

Background Information

Earth's axis is tilted with respect to the sun at an angle of 23.5°. Earth's tilt affects both the intensity of the sunlight we receive and the number of daylight hours. The *summer solstice*, which is the longest day and shortest night of the year, occurs on or near June 21st for the northern hemisphere. After June 21st, the days get shorter until on or near December 21 when the northern hemisphere has the *winter solstice*, the shortest day and longest night. There are also two *equinoxes* throughout the year: one occurs on or near March 20, the other on or near September 23. You can observe the changing number of daylight hours by recording and graphing the time of sunrise and sunset.

Invitation to Learn

Ask students to write how the time of the sunrise and time of the sunset changes throughout the year.

Instructional Procedures

Materials

- ❑ Times of sunrise and sunset
- ❑ Graph paper
- ❑ Paper
- ❑ Pencil
- ❑ Colored pencils
- ❑ Rulers

1. Have students create a table similar to the one below on a sheet of paper to record their data.

Date	Sunrise	Sunset
1/21		
2/21		
3/21		
4/21		
5/21		
...		
12/21		

2. The time of sunrise and sunset can be obtained from various sources. One way is using the "Starry Night Backyard" program. Another is going to the Web site http://aa.usno.navy.mil/data/docs/RS_OneYear.html, this will give you the actual sunrise and sunset times for a whole year.
3. Have students record the times in their charts.

   Note: This works best if you use military standard time.
4. Finally, have students create a graph of their data. There are several ways to do this. You may have them do it on there own or in groups. In classes with special needs students you may choose to create a class graph on a large piece of paper.
5. Have students make a grid and label the vertical axis *time of day* and the horizontal axis *date of observation*.
6. Have students plot the data and connect the dots with a line.
7. Students may color in the area above and below the graph (optional).

Possible Extensions/Adaptations/Integration

- Sunrise and sunset data for a period of time (e.g., September to December) may be collected from your local newspaper. Each time you collect the data, record it on a large graph and then have students add the new data to their science journals.

Assessment Suggestions

- How does the length of day change with the seasons?
- How many hours of daylight did we receive on June 21st, September 21st, December 21st, and March 21st? What is special about these dates?

Additional Resources

http://aa.usno.navy.mil/data/docs/RS_OneYear.html

http://www.space.com

The Analemma

Science Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1:
Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles

Content Connections:
Language Arts I-1, VI-1

Science Standard II

Objectives 1 & 2

Connections

Background Information

An *analemma* is a lopsided figure-eight shape that shows the apparent motion of the sun across the sky. In this activity we begin to create an analemma. The goal is to show students that the sun's position in the sky is not constant. As summer approaches, the sun rises higher in the sky, giving more intense heat to Earth. As winter approaches, the opposite is true. The sun is lower in the sky thus giving less intense heat to Earth. This is because Earth's axis is tilted at an angle of 23.5°. This explains the sun's apparent north and south track across the sky. However, the sun also appears to move eastward and westward at a specific time because Earth's orbit around the sun is an ellipse.

Safety Note

Remind students that it is never wise to look directly at the sun as it may cause permanent damage to the eye.

Invitation to Learn

Ask students what they can do to show that the sun's position in the sky isn't changing. Discuss their ideas on how to prove this.

Instructional Procedures

Materials

- ❑ Southern facing window with direct sunlight
- ❑ Masking tape
- ❑ Permanent marker

1. Prior to the activity, find a southern facing window that has good exposure to the sun and nothing to block the sun like trees. If you do not have one in your classroom, you might find one in a central location such as the cafeteria or library. Mark where you will place the mirror and be sure to put it in the exact same position each time.
2. Obtain a small mirror, one or two inches across is adequate. Place the mirror in the windowsill and check that the area it reflects on is free of obstacles such as lights. If the area isn't clear, you can either move the mirror or do the activity at a different time. If you can tape the mirror permanently in place, do so. Otherwise, mark the spot where you place the mirror. It is very important that the mirror be in exactly the same position each time you take a measurement.
3. On a piece of masking tape, write the date and time, then place the tape on the ceiling in the middle of the light reflected from the sun.
4. One to two times a week, at the exact same time each day, write the date and time (on a new piece of tape) and place it in the middle of the reflected light. Be careful of daylight savings time; it is probably best to just use standard time.

Possible Extensions/Adaptations/Integration

This is a great opportunity to discuss reflection. It is easy to show that the angle of reflection is opposite the angle of incidence during this activity. As the sun moves one way across the sky, the reflected sunlight on your ceiling moves in the opposite direction.

You create a crude analemma in this activity. Use the links listed under *Additional Resources* to gain additional information on analemmas.

Assessment Suggestions

The following questions can be discussed orally as a class or in groups. You may also have students write the answers to these questions in a science journal.

- In which direction do you expect the light to move as winter approaches?
- In which direction do you expect the light to move as summer approaches?
- Do you think the light will move in any other direction?
- Do you think that the light reflected on the ceiling from the sun will be in the exact same spot one year from today? Why or why not?
- Students draw the position of the sun in their journals and label each measurement.

Additional Resources

http://www.analemma.com/Pages/framesPage.html

http://sundials.org/links/local/pages/dicicco.htm

http://rathnasree.htmlplanet.com/analemma_activities.htm

Family Connections

Have students try this activity at home with their family and report on how it worked.

Science Standard VI (Heat and Sound) Activities

Bing! Bang! Boom!

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 1:
Investigate the movement of heat between objects by conduction, convection, and radiation.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning
5. Demonstrate Awareness of Social and Historical Aspects of Science
6. Understand the Nature of Science

Content Connections:
Language Arts I-2, VI-2, VII-3, VIII-6; Math IV-2, V-1

Science Standard VI

Objective 1

Connections

Background Information

Heat Energy

Particles that make up substances are always moving and always have energy. This energy can be transferred from one object to another by three means—*conduction*, *convection*, and *radiation.*

There is a difference between heat and temperature. *Heat* is the energy that the object has because the particles are moving. *Temperature* is a way of measuring heat energy. Two scales that are commonly used to measure heat are the *metric system* and the *standard system*. The metric system uses *celsius* (ºC), and the standard system uses *fahrenheit* (ºF) to measure heat. The measurement of temperature gives the average amount of energy contained in the substance.

Heat always travels from hotter to cooler objects. It may seem that when you are holding an ice cube, the ice cube is causing your hand to feel colder. However, the real physics behind this heat transference is: The feeling of coldness in your hand is caused by the heat flowing away from your hand and into the ice cube. REPEAT: Energy from the faster-moving (hotter) particles transfer to the slower (colder) particles. The transfer of energy goes on until all the particles in both objects are moving at about the same speed. When the amount of heat energy of each object is the same, both objects will have the same temperature.

Conduction

When two objects come into contact with each other, heat energy moves between them because the particles in one object collide with, or 'bing,' the particles in the other object. Transferred heat resulting from

the collision of particles is called *conduction*. Conduction works best through solids, especially through materials such as metals. An example includes observing a raw egg fry as it hits a heated frying pan.

Convection

Heat energy transferred by the movement of a liquid or gas is called *convection*. When particles are heated, they move faster, expand, become less dense, and 'bang,' the particles rise. As the liquid or gas cools, the particles move slower, contract, become more dense, and 'bang,' the particles sink. This movement of heating, expanding, rising, cooling, contracting, and sinking is a continuous one. An example is to observe the amount of wind in the early morning compared to the afternoon. Wind is an example of a convection process in motion.

Radiation

Conduction and convection need a medium to transfer heat energy; however, radiation does not. *Radiation* uses electromagnetic waves such as ultraviolet, visible, infrared, and microwaves, 'boom.' These invisible waves carry energy through empty space, as well as through solids, liquids, and gases. All objects give off electromagnetic radiation, which means warm objects emit more radiation than cool objects. An example is the radiation from a campfire making you feel warm as you roast marshmallows.

Invitation to Learn

Set up a microwave oven in front of the classroom and pop a bag of popcorn. Ask students several questions relating to what's going on inside the microwave oven.

Sample Questions:

1. What type of energy is a microwave using?
2. Why does it pop popcorn? Where did the energy come from?
3. Why does the bag feel hot when you first pull it out?
4. Why should you wait a few minutes before eating the popcorn?
5. Where did the steam vapors come from?
6. Feel the air just above the bag as you open it. Why is it warmer than the surrounding air?

During this discussion, list student ideas on chart paper. Revisit this list at the end of the heat unit.

Instructional Procedures

Activity #1—'BING'—Melting Ice Using Conduction

Activity Time: 20 minutes

1. This is a short demonstration with room temperature water and ice. Using a thermometer, take the temperature of a glass of room temperature water. Add several ice cubes to it and let set for a few minutes. Take the temperature of the water after having ice added to it. Have a short discussion about the following question: When you add ice to warm water, does the warm water melt the ice or does the ice make the water colder?
2. Explain to students that they are going to see who can melt an ice cube the fastest using only their hands.
3. Give a container to each group of students filled with enough ice cubes for every student to have his/her own.

   Option: Place each ice cube in a Ziploc bag.
4. Explain to students that they will all begin at the same time.
5. Give the signal to begin.
6. After the initial mayhem and students are complaining about their hands freezing, ask students why their hands are so cold? Ask if the ice made their hands cold or did the heat from their hands cause the ice to melt? Ask how this experience relates back to the initial question about the ice and water.
7. Ask students what would eventually happen to the temperature of the ice water if left alone for 24 hours.

Materials

For each group:

- ❏ Container
- ❏ Paper towels

For each student:

- ❏ Ice cube

Activity #2—'BANG'—The Effect the Convection Process has on Patriotic Water

Activity Time: 75 minutes

Materials

For each group:

- ❑ Set of two clear plastic cups
- ❑ Thermometer
- ❑ Container of ICE cold water (0ºC)
- ❑ Blue food coloring
- ❑ Container of ROOM TEMPERATURE water (23-25ºC)
- ❑ Container of BOILING water (90-100ºC)
- ❑ Red food coloring
- ❑ Paper towels

For each student:

- ❑ Clear plastic cup (5 oz.)
- ❑ Small syringe

Advance Preparation

Ice Water

The night before, freeze a large block of water (or several trays of ice cubes) dyed with blue food coloring. In the morning, place blue ice in a pitcher and pour a small amount of water over ice. Allow ice to melt into a liquid state but keep as close to 0ºC as possible. When pouring out ice water for each group, it is recommended that you use Styrofoam® cups.

Room Temperature Water

In the morning, fill enough clear plastic cups 2/3 full so that each group has two cups as well as each individual student having one cup. (Example: If you have 30 students, you will need 30 cups, plus enough for each group to have two additional cups.) Water needs to be at room temperature and not right out of the tap.

Note: It is suggested to make several extra for those students who need a "do over."

Hot Water

Just prior to the activity, bring a pitcher of water to a boil and add red food coloring to it. Caution students to be careful!! When pouring out hot water for each group of students, it is recommended that you use Styrofoam® cups.

Procedure

1. Give each group two plastic cups filled with room temperature water, a container of ice water, and a container of hot water. Have students take the temperature readings for the ice water and the hot water and record their data.
2. Give each group a syringe and discuss the appropriate use of this instrument. Use the syringe to measure out 30ml of ice water from the container and slowly put in one of the plastic cups containing room temperature water. Have students make and record observations of what happens to the ice water.
3. Have another person from each group use the syringe to measure out 30ml of hot water from the container and slowly put in one of the plastic cups containing room temperature water. Have students make and record observations of what happens to the hot water.

4. Discuss in detail student observations on how the ice water reacted and the hot water reacted in room temperature water. Ask students why each type of water reacted the way it did. Use this opportunity to connect with the convection process and the movement of particles.
5. Explain to the students that they will be making a patriotic cup with layered red, white, and blue water. Emphasize to the students that each layer is just water and that the amount of heat energy is the only difference in the water's behavior.
6. Discuss effective strategies on how to use the syringe to get the best results. (Creating purple water is not the objective.)
7. Before students begin layering their water, have them take the temperature reading of the room temperature water and record this data.
8. Once students have their water layered in red, white, and blue, have them draw diagrams of their observations in four 15-minute internals.
9. After each 15-minute internal, have a short discussion about what students are observing. Direct their focus on how the ice and hot water's behavior is changing over time. Ask students why the blue ice water is rising. Why is the red hot water sinking? What will your water look like after 45-minutes? What effect is the convection process having on layered patriotic water?
10. After 60-minutes, have students take the temperature of their now 'purple' water. Have students explain this temperature reading relating it to the convection process.

Activity #3—'BOOM'—Make It Fly With Radiation

Activity Time: 30-minutes

A warm, sunny day is recommended to do this activity.

Materials

- ❏ Solar bag
- ❏ String

1. Take students outside on the playground and have them sit in a circle.
2. Unfold the black deflated solar bag in the center of the circle.
3. Ask students to problem solve variables to be considered in order to make the black solar bag fly.
4. Choose one student to take the solar bag and run with it. When it is full of air, tie off the ends.
5. Place the semi-filled solar bag in the middle for further observations.

6. As the sun heats the air inside the solar bag, have students record in their journal what is happening and encourage them to make conjectures explaining what is happening in regard to conduction, convection, and radiation.

   Note: Make sure to tether the solar bag with string so it does not fly away—especially with wind present.

   Caution: Read all safety directions on your solar bag.

7. Have several students share their conjectures and discuss how the three means of heat transference all work together simultaneously to make the solar bag fly.

Possible Extensions/Adaptations/Integration

- For a summary review, complete a hierarchy graphic organizer.
- Take the major big ideas regarding heat and have students create pages (using 18" x 24" construction paper) that will be combined into a class *Big Book of Heat*.
- In cooperative groups, students complete poster displays explaining how the three types of heat transference are involved with situations such as:

  – a candy bar melting in the car

  – a space heater warming up a room

  – a frying pan cooking a grilled cheese sandwich

  – a popsicle melting on the asphalt

- Have students write a reflection essay explaining why popcorn pops in microwave and how the three types of heat transference are involved in the process.

Adaptations for Learners with Special Needs

1. Ask for parent volunteers to supervise small work groups.
2. Pair students with special needs with peers who can help during group activities.
3. Diagrams or explanations: Use short phrases with key words listed on the board. Verbal clues help with definitions.

Assessment Suggestions

Performance Task

- Have each student make a solar oven out of a pizza box. Encourage students to make at least one modification from the instructions to make their solar ovens more effective.
- Place a thermometer in each solar oven. Take a temperature reading prior to going outside and after the solar oven has been sitting in the sun for at least 30 minutes. Record data. Caution students not to pick up metal thermometers after solar ovens have been outside for any length of time.
- Give each student the makings for a S'More and a small plate. (They get messy!) Have students predict which will melt first: the chocolate or the marshmallow. Have students place their S'Mores in their solar ovens and make four observations: once every five minutes over a 20-minute period.
- After eating their S'Mores, have students explain in detail how the heat transference of conduction, convection, and radiation are all involved in cooking the S'More. Include in the explanations which melted first and why. Have students use science language and the basic concepts learned about heat. Encourage students to include diagrams with the explanations.

Resource Site

Make A Pizza Box Solar Oven, http://www.solarnow.org/pizzabx.htm

Suggested Constructed Response Activities

Choose one or more teacher demonstrations to do in front of the class. Have students explain the science behind the demonstration(s) using science language and the basic concepts learned about heat. Encourage students to include diagrams with the explanations.

Suggested demonstrations:

1. Heating up a metal rod on a stand with attached wax balls.
2. Compare the following methods of melting an ice cube:
   a. Place an ice cube under a heat lamp for several minutes to cause it to melt.
   b. Place an ice cube in a large tub, pour a bucket of cold water over the ice cube.
3. Explain a wind machine.
4. Heating up a metal ring and ball set.

5. Galileo's Thermometer
6. A radiometer

Additional Resources

Books

Elmer in the Snow, by David McKee (Lothrop, Lee & Shepard Books); ISBN 95077472

Teacher Resource Books

Convection: A Current Events, (GEMS, http://www.lhsgems.org, 510-643-0309); ISBN 0-912511-15-X

Hot Water and Warm Homes from Sunlight, (GEMS, http://www.lhsgems.org, 510-643-0309); ISBN 0-912511-24-9

Primarily Physics: Investigations in Sound, Light, and Heat Energy, (AIMS, http://www.AIMSedu.org, 1-888-733-2467); Item 1104

Videos

Heat, by Bill Nye (Disney Educational Productions, 1-800-295-5010, http://dep.disney.go.com/educational/index); Product ID: 68A71VL00

The Transfer of Energy, (Schlessinger Media, 1-800-843-3620, http://www.libraryvideo.com); N6667

Heat, Temperature and Energy, Live Action Video (Rainbow Educational Media, 1-800-331-4047, http://www.rainbowedumedia.com/); Product ID: RB8229

Web Sites

6th Graded Sciber Text, http://www.usoe.k12.ut.us/curr/Science/core/6th/sciber6/6th/index.htm

NTTI Lesson: Conduction, Convection, Radiation, http://www.wnet.org/edonline/nttidb/lessons/13/cndct13.html

Additional background information on Conduction, Convection, and Radiation, http://www.lanly.com/heating.htm

Science Teacher Stuff-Resources for K-12 Teacher (Several lessons plans on Heat), http://scienceteacherstuff.com/heat.html

Family Connections

1. Over a seven-day period, have students keep a running list of examples of heat transference observed at home, with a short justification and explanation for each.
2. Have students become the science teacher at home by having them replicate the popcorn in the microwave activity for their families. Have the students then ask family members to explain why a microwave can pop popcorn.
3. Discuss with students the accessibility of electrical energy and the ability to survive without it. Have students design a home project that will assist people in time of power outages to have access to energy using simple heat transference. Projects could focus on helping people cook their food, heat water, keep warm, etc.

Making Waves, Making Music, Making Noise

Science Standard VI

Objective 3

Connections

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 3:
Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning
5. Demonstrate Awareness of Social and Historical Aspects of Science
6. Understand the Nature of Science

Content Connections:
Language Arts I-2, VI-2, VII-3, VIII-6

Background Information

Consider a teacher's most frequent request throughout the day, "Quiet, please." Whether it's the insistent talking, the pencil tapping, the humming, the ongoing shuffling, or the strange and bizarre noises that emit from children—teachers are constantly asking for quiet. Why? Because children are masters at vibrating the particles around them, therefore creating—SOUND—and lots of it. *Sound* is a form of energy made by vibration—the complete back-and-forth motion of an object. This includes vibrations of anything that is a solid, liquid, and/or gas. Therefore, the chances of a child making vibrations are extremely great, varied, and frequent. However, sound cannot be made in a vacuum or in outer space where there is nothing to vibrate.

Quick Review: Sound is created with vibrations but cannot be made in a vacuum or out in space.

Solution: Be able to convert your classroom into a vacuum or contact NASA for a grant.

Sound waves are caused by vibrations through a material medium and will go out in all directions from their source. A medium is a substance through which a wave can travel. (However, the material medium just vibrates back and forth and helps transfer the sound energy. It is not carried along with the sound wave.)

Example: At the peak of lunch time in the cafeteria, when hundreds of children are eating and talking and vibrating the air (gas), the tables (solids), and the milk cartons (liquids). All of these vibrations go out in all directions from each of their little sources creating a great cacophony.

Quick review: Sound waves need a medium to travel through and will travel in all directions from the source of vibration.

Solution: Reduce the number of mediums in a given environment through which sound can travel.

The quality of the sound that children make is purely subjective. However, strictly and factually speaking, the number of sound waves an object produces in a second is called frequency. The *frequency* of vibrations determines how high or low the pitch of the sound is. The faster the object vibrates, the higher the perceived pitch. The slower the object vibrates, the lower the perceived pitch will be. The size and shape of an object will also affect the pitch.

Quick review: Pitch is how high or low a sound seems to be and is determined by the number of vibrations per second. Pitch also determines the extent of how far your last nerve is plucked.

Solution: Determine which range of highness or lowness you can tolerate and remain happy and calm. Using effective behavior modification techniques, teach your students to stay within this range.

The major differences between all creatures young and old is the amount of energy they possess. The young seem to have an endless supply, the old somewhat more limited. This amount of energy has a direct correlation to the volume of sound created. When an object is struck lightly, with little energy, it makes a soft sound. When more force is applied, it produces more energy, making a louder sound. That's why teachers will compromise and say, "Use your soft voice when talking," in hopes of encouraging children to apply less force onto their vocal cords.

Quick review: Volume is how loud or soft a sound seems to be and is related to the amount of energy contained in the vibrations. It is also the single most determining factor that constitutes a successful day of teaching.

Solution: Reduce the amount of energy in your classroom. Running multiple laps around the field in all kinds of weather is highly recommended.

Invitation to Learn

Choose a 'Talking Can' to demonstrate to students the sound it produces. (To get maximum sound from a 'Talking Can,' slide a small damp sponge or baby wipe across the cotton string. How you slide across the cotton string gives you different effects (e.g., short, jerky motions verses long, smooth motions).

Pick up a different size can and ask students how the sound from this can will compare to the first can. Encourage students to observe the shape and size of the can as they think how the sound will be affected. Encourage students to think about why the different shapes and sizes of cans create different sounds.

Instructional Procedures

Activity #1—Making Waves with 'Talking Cans'

Activity Time: 45 minutes

Materials

- ❑ Empty tin cans
- ❑ Cotton string (medium thickness)
- ❑ Scissors
- ❑ Several thin sponges or baby wipes
- ❑ Large paper clips
- ❑ Duct tape
- ❑ A variety of toy-type objects that make noise

Advance Preparation

- Make several 'Talking Cans' using different shapes and sizes of empty tin cans. The more variety the better for this activity. (Use empty cans from canned foods; check with cafeteria workers for large cans.)
- Tin cans should be empty, clean, with one end of the can completely opened, and sharp edges filed down.
- Make a small hole in the center of the top of each can.
- Cut a meter-length of cotton string for each can.
- Thread the string through the hole in the top of the can and tie the top end to a large paper clip. Secure the paper clip (that has the tied string to it) with a piece of duct tape to the top of the can. The remaining string should be free to hang from the inside of the can with the top secured with duct tape.
- Continue this process for all tin cans.
- Prior to this activity, select a short story that has several characters that can be portrayed with different sounds. Make a list of characters and assign which 'Talking Cans' and other sound makers will be used for each character.

  Hint: Stories that have several animal characters work well.

Activity

1. Tell students that they will be performing the sound effects for a story.
2. Assign students to various 'Talking Cans' and other sound makers.
3. Tell students that when they hear their character mentioned, they are to follow immediately with the corresponding sound.

4. Before you begin reading the story, have students practice their sound parts. Instruct students to make their sound as quiet . . . as loud . . . as high . . . and as low as they can.
5. As you read the story, pause for a moment to allow students to perform their sounds. Modify the story so students have to play quiet, loud, high, and low sounds.

   Advisory Hint: Keep the pace of the story moving.
6. After the story, talk more in depth about the science behind the sounds. Select two 'Talking Cans' that vary in shape and size. Have students discuss as a group the differences in sounds. Ask students:
   - Why do these two cans make different sounds?
   - Which one makes the higher sound and why?
   - Which one makes a lower sound and why?
   - Can you make the sounds softer? louder? How?
   - Is there a way you can make lower sounds on the smaller can? How? Why does this work?
   - Is there a way you can make higher sounds on the larger can? How? Why does this work?
7. Choose two different cans that vary in shape and size. Have students go through the same comparison process, writing responses to the same types of questions in their journals. Encourage students to use labeled diagrams.

Activity #2—Making Music, Making Noise

Activity Time: 30 minutes

Advance Preparation

- Cut a meter-length of each of three different weights of fishing line.
- Using a utility knife, carefully make three slit-type notches on both ends of the wooden slat board.

  Note: Keep in mind the diameter size of each type of fishing line and make notches accordingly.
- Tie a large knot at one end of each fishing line.
- Thread each line through the 3" piece of PVC pipe and then secure the knotted end into the slit-type notches. After all three are secured to one end of the board, wrap a piece of duct tape around that end to help prevent strings from slipping.

Materials

- ❑ Wooden slate board 1 1/2" x 1/4" x 20". (A meter stick cut in half also works.)
- ❑ 1" inside diameter PVC pipe, cut into a 3" length, with pre-drilled holes to allow three strings of fishing line to go through.
- ❑ Fishing line of three different weights/test strengths (e.g., 6 lb., 20 lb., and 50 lb.)
- ❑ Utility knife
- ❑ Duct tape
- ❑ Set of "Boomwhackers"

- To secure the other end, pull each string to find the amount of tension it can take. Make a knot at the tension point and secure with a slit-type notch. After all three strings have been secured, wrap a piece of duct tape around to help prevent strings from slipping.
- These instruments can be used:
  - As a class demonstration.
  - In a sound center.
  - With each group of students if cooperative groups are used and if you make enough for each group.
  - As an introduction to making individual musical instruments.

1. Have students think about the following questions as they manipulate the BoJo. Record their responses in their journals.

   Move the PVC piece slowly up and down the base.
   - What does lengthening and shortening the strings do to the sound?
   - Why do you get higher sounds with shorter strings?
   - Why do you get lower sounds with longer strings?

   Pluck the strings gently.
   - What happens to the volume?
   - Why does it become softer?

   Pluck the strings harder.
   - What happens to the volume?
   - Why does it become louder?

   Move the PVC piece 3/4 up the board. Play the thinnest string and the thickest string.
   - Is there a difference in sound?
   - Why is the thinner string higher than the thicker string if they are both the same length?
   - Is there a way to make the pitch the same between the thinner string and the thicker string?

2. Have students think about the following questions as they manipulate the 'Boomwhackers.' Record their responses in their journals.
   - Predict which of the 'Boomwhackers' will give the highest sound when played properly. Arrange the rest of the "Boomwhackers" in order from highest to lowest.

- Record your prediction in your journal.

Note: Playing the 'Boomwhackers' properly is gently tapping each tube on your own head and listening to the sound.

- Test your prediction and record data in your journal.
- Explain in detail why the shorter tubes make the higher sounds and the longer tubes make the lower sounds.

Possible Extensions/Adaptations/Integration

- Focus on cause/effect relationships and use a flow chart graphic organizer.
- Design an advertisement for this instrument. Include the following:
  - An original name.
  - List of features the instrument can do.
  - A diagram illustrating how it works.
  - An explanation of the science behind why it works.

Adaptations for Learners with Special Needs

- Reduce length and/or complexity of written assignments and post vocabulary and key concepts in the room.
- Have the class help design a scoring rubric to assess their musical instrument. Establish time lines to guide students in project completion.
- Communicate the expectations and timeline of making a musical instrument to students and their parents. Come to an agreement on any adaptations that might be helpful for individual students.

Assessment Suggestions

Performance Task

- Make an instrument that has the following criteria:
  - It is durable and can be played.
  - It can be played loud or soft.
  - It can play both high and low pitches.

Constructed Response

- Choose one or more demonstrations to do in front of the class. Have students explain the science behind the demonstration(s) using science language and the basic concepts learned about sound. Encourage students to include diagrams with their explanations.
- The following are suggested demonstrations:
  - Resonating box and tuning fork
  - Singing tube
  - Popping tube
  - What's wrong with the video clip in *Star Wars* when there is sound coming from lasers in space?

Additional Resources

Books

Horrible Science-Sounds Dreadful, by Nick Arnold (Scholastic); ISBN 0-439-20723-1

A World of Sound, by Nancy Leber and Robin Bromley (Newbridge Educational Publishing, http://www.newbridgeonline.com, includes Teacher Resource Book); ISBN 1-56784-478-2

Light, Sound, & Electricity, by Kirsteen Rogers, Phillip Clarke, Alastair Smith, and Corinne Henderson (The Usborne Internet-Linked Library of Science, Scholastic); IBSN 0-439-44147-1

Primarily Physics: Investigations in Sound, Light, and Heat Energy, (AIMS, http://www.AIMSedu.org, 1-888-733-2467); Item 1104

Web Sites

6th Grade Sci-ber Text,
http://www.usoe.k12.ut.us/curr/Science/core/6th/sciber6/6th/index.htm

SciLinks, http://www.scilinks.org, "What is sound?" – Code SFS01, "Properties of sound" – Code SFS02, "Sound Quality" – Code SFS03, "Vibrations and Waves" – Code SFS04

The Usborne Internet-Linked Library of Science,
http://www.usborne-quicklinks.com

Science Teacher Stuff-Resources for K-12 Teacher,
Web links to several lessons plans on Sound,
http://scienceteacherstuff.com/sound.html,
http://scienceteacherstuff.com/heat.html

Videos

Sound, by Bill Nye (Disney Educational Productions, 1-800-295-5010, http://dep.disney.go.com/educational/index); VHS Product ID: 68A99VL00, DVD Product ID: 77A34VL00

The Way Things Work—Sound, (Schlessinger Media, 1-800-843-3620, http://www.libraryvideo.com); K7861

Breaking the Silence: An Introduction to Sound, Live Action Video, (Rainbow Educational Media, 1-800-331-4047, http://www.rainbowedumedia.com/); Product ID: RB814

Family Connections

- Quietly sit somewhere in your home for five minutes. Record all of the sounds that you hear in that time frame.
- Have each student select a short story with accompanying sounds, family members perform the story with sound effects.
- Have each student build a model of a simple 'telephone' using cups and string. Try it with family members. Record observations and discoveries. The following may be used to help with the investigation:
  - Stand apart the distance of the string on the phone. Begin talking softly to your partner without the telephone. Now talk at the same level using the telephone—make sure the string is pulled tight. Why does talking through the 'telephone' make it easier to hear your partner?
  - Talk to your partner in a very low voice. Then talk in a very high voice. Why do lower pitches sound clearer than higher pitches through the 'telephone'?
  - Talk to your partner in a low voice with the string relaxed and saggy. Why do tight strings work better than saggy strings?
  - Design a way to have a conference call with more than two people. Draw a diagram of your design. What features made it work the best?
  - Why does adding more people to the 'telephone' system make the sound less clear?

Science Standard VI (Light) Activities

I'm So Bright I Wear My Shades Indoors!

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 2:
Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

Intended Learning Outcome:
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII-3, VIII-6

Science Standard VI

Objective 2

Connections

Background Information

Energy is defined as the ability to do work. *Heat, light,* and *sound* are all forms of energy. Some of the things they have in common are that they all travel in waves and can all be reflected (angle of incidence equals the angle of reflection).

Light is everywhere. It is really the only thing we can see, because when you look around you, you are looking either at a light source or something that is reflecting light. Every living thing depends on light energy in some form or another.

Light can be thought of as traveling in rays, which move in straight lines until they hit something. Light also travels in a series of waves. It is only part of a group of waves called *electromagnetic waves*. Radio waves, microwaves, and other types of radiation are constantly surrounding us, along with infrared rays, ultraviolet radiation, X-rays and gamma rays. Scientists have grouped these together and labeled them the *electromagnetic spectrum*.

The sun is our greatest source of light and energy. Other natural light sources include stars, fire, lightning, fireflies, and some bioluminescent animals. Invented light sources include: light bulbs, lamps, lasers, fireworks, flares and glow sticks, etc. Moonlight is not considered a light source because it actually reflects sunlight.

Invitation to Learn

Introduce the concept of energy to students by writing what they know about energy on a chart. Ask for specific examples of energy, and encourage students to specify how they will know when energy is present.

Materials

For each student:

- ❑ Two UV beads
- ❑ Pipe cleaner
- ❑ Paper/pencil/clipboard
- ❑ *Energy Song*

Instructional Procedures

1. Tell students you are going outside on an energy hunt, but first they must put on some energy detectors.
2. Hand out two UV beads and a pipe cleaner per student. Instruct them to place beads on the pipe cleaner and attach it to their wrist.
3. Students will take a pencil and paper (clipboard if available), and go outside for a few minutes to observe and draw the energy they see. Encourage them watch for as many forms of energy as they can see. They should notice that their UV beads have changed color.
4. After a few minutes of students drawing and observing, have them come back in and discuss their observations.
5. Classify their findings and chart them as a class, such as natural and invented light sources or sources of light and reflectors of light (anything that is not a light source is a reflector of light).
6. Sing the first two verses of *Energy Song* (p. 8-7).

Possible Extensions/Adaptations/Integration

1. Study of the electromagnetic spectrum is reserved for upper grades, however, a short introduction will help students better understand how visible light fits into everything. One way to teach it is to divide students into groups and have each group choose a part of the electromagnetic spectrum to research, then draw a poster of. Their findings should include ways we use this energy in everyday life. Posters can then be displayed on a bulletin board.
2. Make a compare/contrast chart comparing natural and invented light sources. Students draw or write at least ten examples of each. Provide books with unusual light sources such as bioluminescent animals or chemicals that produce light.
3. *Adaptations for learners with special needs:* Have students work with a group or buddy learner who can help with work. Choose several key words or terms for students to learn, instead of expecting mastery of everything.

Assessment Suggestions

- Make a light book out of 12" x 18" art paper with examples of light sources, and one page of misconceptions of non-light sources, such as moonlight.
- Have students draw or list ten examples each of natural and invented light sources.

Additional Resources

Books

The Wonder of Light, by Jan Adkins (Ranger Rick Series, Newbridge Educational Publishing); ISBN 1567844758

The Usborne Internet-Linked Library of Science Light, Sound & Electricty, Kirsteen Rogers et al. (Scholastic); ISBN 0-439-44147-1

Videos

Electromagnetic Energy, (Schlessinger Media, 1-800-843-3620, http://www.libraryvideo.com); N6661

Eureka!, section on Electromagnetic Spectrum (offered by Utah Education Network several years ago, created by TV Ontario, may still be available from district office)

Web sites

http://www.scilinks.org
(type in code to receive listing of approved Web sites), Topic: reflection – Code: SFL01, Topic: properties of light – Code: SFL03, Topic: electromagnetic spectrum – Code: SFL05

Basic facts about light and online activities for students.
http://www.opticalres.com/kidoptx.html

If you have a color projector, this Web site is perfect for teaching the electromagnetic spectrum with color photos, etc.
http://imagers.gsfc.nasa.gov/ems/ems.html,

Great color photos introduce students to the electromagnetic spectrum and visible light.
http://www.thetech.org/exhibits_events/online/color/light/

Family Connections

Assign students a home project about light and color. This is something they should do at home, and share with the class at the end of the unit. In the instructions that are sent home, include Web site resources and project ideas.

Example:

This month we will be studying energy in the form of light. For their at-home project, students may choose to do a poster, bring a model, or demonstrate something for the class about light or color. The written report of their project and what they learned must be at least two paragraphs and can be typed or hand-written.

This project is worth 50 points.

5 points	Turned in on time.
25 points	Drawing, model, or demonstration.
20 points	Written description of research, in paragraph form.

Ideas for the Project:

- Model of the eye and how we see.
- Demonstration of colors of light, including homemade prisms.
- Model, poster, or demonstration of reflection or refraction of light (this might include a homemade kaleidoscope).
- Making a solar oven or solar cooker of some sort.
- Report or demonstration of how light is bent through lenses.
- List of 20 ways mirrors are used in everyday life.

Name _____

Energy Song

Tune of "Friend Like Me" (Disney)
Words: Vickie Ahlstrom

Well, heat and light and sound, you see
Are forms of en-er-gy.
All travel in waves, but first let's see
How fun Light can be.
In the E-lec-tro-magnetic
Spectrum, filled with waves
Light waves are the only waves
That our eyes can see.

Radio, microwave, infra red,
Visible light, that's ROY G BIV,
UV, X and Gamma Rays,
(Just watch out for UV).

When light rays hit an object
Some will be absorbed
They can reflect, or refract,
or even pass right through.
Yes sir, opaque can reflect, or just block
Transparent you can see
Translucent's fuzzy, some go through
And some come back to me.

And with a concave lens
The light will just diverge.
But convex, focus on "X,"
Helps us all to see.
Ya...dah...dah...oh, my,
Ya...dah...dah...nah, nah
Lah...de...dah, hah, hah,
Cha...che...dah...de...dah..doo...dah

What makes Sound great
Is when things vibrate
And the pitch, in hertz, is frequency...
It's high...or low...
And volume, measur-ed in dB
Is how much energy.

Heat can transfer in three ways
Rad-i-ation, in space and air
Like microwaves and marshmallows
And sun warming the air.
Con-duction is passed by touch
From hot to cold, it's true.
Like pancakes on the griddle
Or that hot rock in your shoe.

Convection is through the air
And water currents, too.
The heat will rise, the cold will sink
'Til they all mix, 'til they all mix,
'Til they all mix, 'til they all mix,
Until they...have the...same...en-er-gy.
Hah, hah, hah....La...la...la...
They're all just forms of energy, Hah!

Enlightening Explorations

Science Standard VI

Objective 2

Connections

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 2:
Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles

Content Connections:
Language Arts VIII-1

Background Information

Light travels so fast that it seems we see things the instant they happen. Light travels at 300,000 km per second, or 186,000 miles per second. Light travels in straight lines. When light hits an object, it can be *absorbed, reflected,* or *pass through* (transmitted). If light passes through a transparent object at an angle, it can also be *refracted*, or bent, because the speed of light slows as it passes from one transparent object to another.

All objects reflect some light, because we can see them, but objects that are smooth and hard are better at reflecting light than others. Mirrors are excellent reflectors because the surface is smooth, and light is able to bounce back. When light hits a surface, it is always reflected at the same angle it strikes the surface. The law of reflection states that the *angle of incidence equals the angle of reflection.* This is best demonstrated by throwing a ball at a smooth surface. The angle at which it hits will equal the angle at which it bounces back (45˚ going in equals 45˚ going out).

With a transparent object (air, water, clear glass) almost all light passes through. Translucent materials (wax paper, bathroom windows) allow some light to pass through while some light is reflected. Opaque materials (wood, metal) block all light and either reflect or absorb the light. As light passes from one transparent material to another at an angle (from air to water, or air to glass), the light will slow down and appear bent. This is called *refraction*. A good example of this is placing a pencil in a clear glass of water. The part of the pencil above the water appears to be broken off from the part below the water. Light shining through a glass or Pyrex® baking pan filled with water demonstrates refraction.

Invitation to Learn

Send one or two prepared shoeboxes (1" hole cut in the lid with *Look Here* written next to the hole; line the inside with pictures, bright paper, etc.) around the room for students to look in. Instruct students not to open the box, but only to look in. After each student has looked in the box, discuss what was seen. Most students say that there was nothing in the box. Have someone open the box, then show what is inside. Why couldn't they see it? There was no light. We can't see anything without light. Today we're going to experiment to discover some of the properties of light.

Instructional Procedures

The following experiments could be used as centers in a science lab, or as whole group activities. If you have limited materials and books, centers are a great way to keep everyone involved with minimal materials. Students rotate from center to center, working and taking notes as they complete each experiment. If using centers, care will need to be taken to ensure that each center takes about the same length of time, and that all materials are carefully returned to the kits.

If you have adequate materials and books for the whole class to do the experiments at the same time, it will be easier to explain the procedure to everyone, and then you can have a discussion at the end of each experiment to ensure that students learned what was expected in the experiment.

Prepared worksheets that teachers can run off for the light centers are included with this activity. *However, greater learning takes place when students are able to design and construct their own lab sheets instead of continually using prepared ones*. The best way to facilitate this process is to have prepared worksheets for the teacher to model and demonstrate, and students to fill in. Discuss what should be written and show examples of good and poorly completed lab sheets to help students gain the experience necessary to construct their own lab sheets. By the middle of the year, or after quite a few labs, students may be given a lab sheet with one or two guidelines of what they should do. By the later part of the year, students should be given blank paper or a science journal to draw and write what they have learned.

Materials

- ❑ Several prepared shoeboxes

How Light Travels:
(for each student)

- ❑ *How Light Travels* worksheet (p. 8-12)
- ❑ Book on light
- ❑ Bag of assorted objects: canning jar lid, foil, transparency, waxed paper, fabric, netting, square of construction paper, 3 x 5 card, penny, empty spool, plastic test tube, 1 oz. food container, clear plastic cup, etc.
- ❑ Flashlight
- ❑ White board or white cardstock

Comparing Light Sources:

- ❑ *Comparing Light Sources* worksheet (p. 8-13)
- ❑ *Situation Cards* (p. 8-14)
- ❑ Three different types of flashlights that vary in intensity and size
- ❑ Laser pen
- ❑ Incandescent bulb in base (will need electric outlet nearby)
- ❑ Fluorescent bulb in base (also needs electric outlet)
- ❑ Set of situation cards copied on cardstock and/or laminated (master included)

Reflective Surfaces:
(for each student)

- ❑ *Reflective Surfaces* worksheet (p. 8-15)
- ❑ Square of aluminum foil (cannot be reused)
- ❑ Flashlight
- ❑ Laser pen
- ❑ A sample of each of the following: sandpaper, white cardstock, black construction paper, stiff plastic (CD case), metal (canning jar lid, underside of stapler), glass (baby food jar, small glass container, etc.)
- ❑ White board or white cardstock

As we do the labs together at the CORE Academy, we begin with completely outlined lab sheets, then learn how to create our own lab sheets, and finally blank paper will be distributed for the last light labs.

Center Set up

For easier set up and clean up, place materials for each student in gallon-size Ziploc® bags in a bin or container for each center. It is helpful to tape a list of what is in each kit on the bag. Number the centers so students will know which worksheet to use for each center. Instructions can be taped on the outside of the bin so that everyone understands what is expected. Explain how students rotate through the centers and how much time is allowed for each center. Spend some time explaining what you are expecting them to write about in their lab write-ups. It is helpful for students to see both good and poor examples of completed lab sheets. Discuss how these examples could be made better, helping them focus on what is expected.

If this is a first time students are working at centers, stop everyone at the end of the first center and have each group share one thing they did well as a group, and one way they could improve. Repeat one or more times as needed.

Possible Extensions/Adaptations/Integration

- Challenge students to list as many different reflective surfaces as they can (at least 100). A section of poster paper or bulletin board can be used to compile a class list. Encourage students to look for extremely unusual surfaces.
- Learners with special needs can be put into groups with others. Instruct each member of the group to help the whole group complete the task. Provide alternative options for demonstrating knowledge, such as diagrams of what was learned, instead of written work.

Assessment Suggestions

Use the lab sheets to assess what students do and do not understand.

Mastery	Sub-mastery	Needs improvement
❑ Completed the task required at the center. ❑ Wrote and drew what happened in the experiment. ❑ Explained in their own words what they discovered.	❑ Completed the task required at the center. ❑ Included some drawings and observations of what was seen. ❑ Somewhat explained what was discovered.	❑ Task was somewhat completed. ❑ Few drawings and observations included. ❑ Little or no explanation of what was discovered.

Additional Resources

Books

Light! Stop Faking It! Finally Understanding Science So You Can Teach It, by William C. Robertson (NSTA Press); ISBN 0-873355-215-6

Eyewitness Science: Light, by David Burnie; ISBN 1-879431-79-3

Focus on Light, by Barbara Taylor; ISBN 0-531-17381-X

Video

Light (National Geographic, 21 minutes, $69.00, 800-368-2728); ISBN 0-7922-6812-1

Family Connections

- This state Web site provides interactive exploration for students and their families. Click on the *Light and Color* box to access the light activities. http://www.usoe.k12.ut.us/curr/Science/core/6th/sciber6/6th/index.htm
- This Web site is filled with light information, experiments, and great things for kids and families. http://www.gomilpitas.com/homeschooling/explore/optics.htm

Name _____

How Light Travels

Big ideas from reading:

_____

_____

_____

_____

_____

_____

Place each item in the bag between the flashlight and a white board to determine what happens when light hits that object. List four examples of each.

- Objects that *allow light* to pass through are: _____

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

- Objects that *allow some light* to pass through are: _____

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

- Objects that *block all light* are:

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

Name _____

Comparing Light Sources

Compare light sources to determine the differences in light.

Light Source	Color	Intensity (how bright)	Direction Light Travels	Temp. Change
Flashlight #1				
Flashlight #2				
Flashlight #3				
Incandescent Bulb				
Flourescent Bulb				
Laser Pen				

Choose a *Situation Card* and describe which light you would use for that situation. Write **three** justifications for your choice.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Situation Cards

Light an entire room.	**Find a key down a tiny hole.**	**Find shoes in a dark closet.**
Highlight a word on the screen.	**Point to a star during a star show.**	**Find a missing ball at night.**
Tell stories in the dark.	**Signal to a friend across the street.**	**Send a light through a tube.**
Decorate at Halloween.	**Carry with you in a small bag.**	**Useful if you get lost.**

Name _____

Reflective Surfaces

1. Set a square of foil on the desk in front of you. Use a light and reflect it up to the ceiling.

   Do you get a good reflection? _____

   Why? _____

   _____

   _____

2. Crumple the foil square, then straighten it out. Use the light and reflect it up to the ceiling.

   Do you get a good reflection? _____

   Why? _____

   _____

   _____

3. Compare both of these to the reflection of the sky on the lake.

   _____

   _____

   Describe the reflection you see when shining a laser light on each of the following objects. Note the size of the reflection: larger, smaller, none.

sandpaper	**white paper**	**black paper**
stiff plastic	**metal**	**glass**

Discovery: _____

_____

_____

_____

Enlightening Explorations, Part II

Science Standard VI

Objective 2

Connections

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 2:
Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Math II-1, IV-2; Language Arts VII-3, VIII-1

Background Information

The Law of Reflection states that when light hits a surface, it is always reflected at the same angle it strikes the surface: *the angle of incidence equals the angle of reflection*. This is best demonstrated by throwing a ball at a smooth surface. The angle at which it hits will equal the angle at which it bounces back (45˚ going in equals 45˚ going out). The angle at which you throw the ball is called the *angle of incidence*, and the angle at which the ball bounces back is called the *angle of reflection*.

Light travels in straight lines, but it bends as it passes from one transparent medium to another at an angle. This is called *refraction*. A good example of this is placing a pencil in a clear glass of water. The part of the pencil above the water appears to be broken off from the part below the water. When the light travels at an angle, one part of the light will reach the water before the other, so it slows a little before the other part slows.

Invitation to Learn

As students continue labs, show an example on the overhead projector of two different sample lab sheets. Have students discuss good things about them, and what could be improved.

Instructional Procedures

Have students continue with science labs.

Possible Extensions/Adaptations/Integration

- After looking at several kaleidoscopes, challenge students to recreate a kaleidoscope pattern on paper.
- Students with special needs can work with learning buddies to complete the task. They may also be assigned copying the words rather than composing whole sentences or paragraphs.

Assessment Suggestions

While students are learning about light, it is always helpful to review what they have learned to determine if more time needs to be spent on explanation before moving on. The following questions would work well with whiteboards where all students write a short answer to the question. This provides quick, accurate assessment to guide your curriculum.

- If the angle of incidence is 25˚, what is the angle of reflection? *(25˚)*
- What do we call an object that allows only some light to pass through? *(translucent)*
- Which object will make the best shadow—translucent, transparent, or opaque? *(opaque)*
- Draw light hitting an uneven surface. *(Student should draw light scattered in all directions.)*
- List the colors in order as seen when light hits a prism. *(ROY G BIV)*
- Which color best reflects the colors of light? *(white)*
- Draw light being refracted. *(Student draws light refracted through water, or pencil in water.)*
- Draw a natural light source. *(sun, stars, fire, lightning, etc.)*
- Write whether the following examples are refraction or reflection:
  - A prism bending light. *(refraction)*
  - A straw seeming broken inside a glass of water. *(refraction)*
  - A kaleidoscope. *(reflection)*
  - The ocean looking very blue under a blue sky. *(reflection)*
  - A sea shell looking closer than it really is. *(refraction)*

Materials

Light

- ❑ *Light* worksheet (p. 8-19)
- ❑ Two copies of *Protractor* (p. 8-20)
- ❑ Two flat mirrors with mirror stands
- ❑ Two hinged mirrors
- ❑ Two laser pointers
- ❑ Two teddy bear counters
- ❑ *Alphabet Letters* (p. 8-20)

Angle of Reflection
Hit the Target

- ❑ *Hit the Target* worksheet (p. 8-19)
- ❑ Two laser pens
- ❑ Two targets made from 3” x 5” index card folded in half
- ❑ Six mirrors with mirror stands

Refraction

- ❑ Two opaque cups
- ❑ Two pennies
- ❑ Eight pencils
- ❑ Graduated cylinder
- ❑ 1-liter bottle of water
- ❑ Eight baby food jars or transparent cups (4 with lids)
- ❑ Small amount of vegetable oil, corn syrup, and rubbing alcohol

Additional Resources

Book

Horrible Science: Frightening Light, by Nick Arnold; ISBN 0-439-20724-X

Videos

Light Optics, by Bill Nye (Disney Educational Productions, 1-800-295-5010, http://dep.disney.go.com/educational/index); Product ID: 68A86VL00

All About Light, (Schlessinger Media, 1-800-843-3620, http://www.libraryvideo.com); VHS K7109, DVD V8854

Assorted Media

Light, Color and Sound GeoKit, Includes three videos on light, color, and sound, as well as transparencies and lesson ideas. (National Geographic) This can be purchased for $259.95; #NA90640

Family Connections

- This state Web site provides interactive exploration for students and their families. Click on the *Light and Color* box to get to the light activities. http://www.usoe.k12.ut.us/curr/Science/core/6th/sciber6/6th/index.htm
- This Web site is filled with light information, experiments, and great things for children and families to learn. http://www.gomilpitas.com/homeschooling/explore/optics.htm

Name _____

Light

Angle of incidence is the angle at which light hits an object. Place a mirror at the edge of the protractor (reflective edge of mirror must be on the 0 line). Use a laser pointer to shine a light from one angle of the protractor and determine at which angle it is being reflected.

Angle of Incidence	**20°**	**60°**	**80°**	**40°**	**70°**	**10°**	**50°**	**30°**
Angle of Reflection								

Discovery: _____

_____

Hinged Mirror

Place a hinged mirror at the edge of the protractor (reflective edge of mirror must be on the 0 line). Move the hinged part to the degree specified, and place a teddy bear in front of the mirror. Count how many reflected images you see.

Angle	**Number of Reflected Images**
10	_____
30	_____
50	_____
70	_____

Discovery: _____

_____

Mirror Images

Set the mirror at 90˚. Each reflected image will then be flipped 90˚.

Draw:

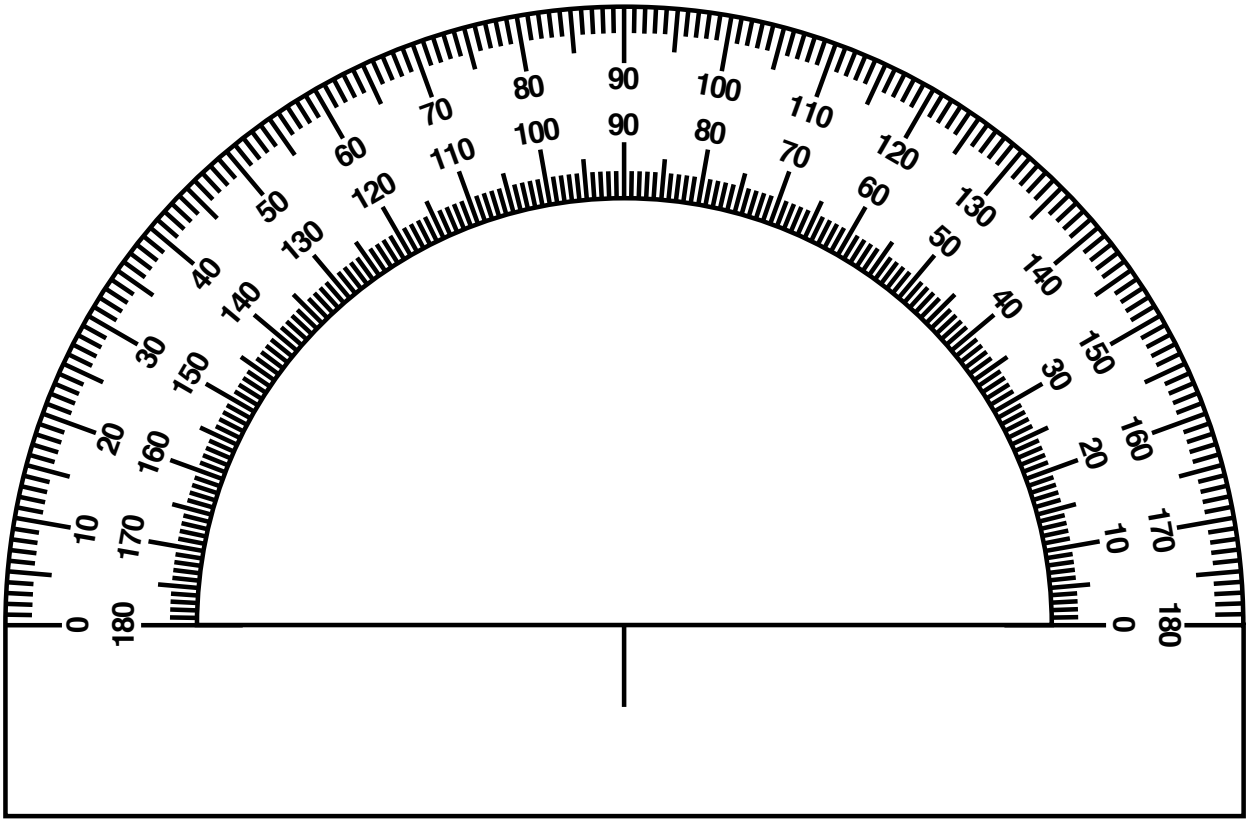
Discovery: _____

_____

_____

_____

Protractor



Alphabet Letters

R B

F E

Name _____

Angle of Reflection: Hit the Target

Place a light on the table and a target somewhere behind it. Use mirrors to create at least three "bounces" before the light hits the target.

Draw how you did it:

Discovery: _____

_____

_____

Combine with another group and try to make six " bounces."

Draw:

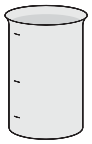
Name _____

Refraction

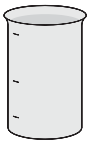
Refraction: Light travels in straight lines called rays at 186,000 mps or 3000,000 km/sec. When light passes through a transparent object at an angle, it slows down. The light waves slow down one by one, bending the light. This is refraction.

1. Reappearing coin (draw the cup, coin, and angle of light)

Before adding water



After adding water



Discovery: _____

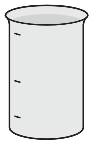
_____

Conclusion: _____

_____

2. Broken Pencils

50ml



100ml

150ml

200ml

Discovery: _____

_____

Conclusion: _____

_____

3. Viscous liquids

Water

Veg. Oil

Karo Syrup

Alcohol

Discovery: _____

_____

Conclusion: _____

_____

Lab Procedure Cards

Light

1. Place a mirror at the edge of the protractor. Use a laser pointer to shine a light from one angle of the protractor and determine at which angle it is being reflected.

   Angle of Incidence: 20˚ 60˚ 80˚ 40˚ 70˚ 10˚ 50˚ 30˚

   Angle of Reflection: ____ ____ ____ ____ ____ ____ ____ ___

2. Place a hinged mirror at the edge of the protractor. Move the hinged part to the degree specified, and place a teddy bear in front of the mirror. Count how many reflected images you see.

   Angle: 10˚ 30˚ 50˚ 70˚

   # of Images ____ ____ ____ ____

3. Set the mirror at 90˚. Place a letter against the mirror and draw the letter as it is reflected (you should draw all four reflections of the letter exactly as you see them).

Hit the Target

1. Place a laser pointer on the table and a target somewhere behind it. Use mirrors to create at least **three** "bounces" before the light hits the target.
2. Draw how you did it.
3. Combine with another group and try to make **six** "bounces." Draw how you did it.

Refraction

1. Place a coin in an opaque cup and adjust your eyes so you can no longer see the coin. Without moving your eyes, slowly add water to the cup until you can see the coin. Draw what you did and write your discovery.
2. Using four transparent cups, pour 50 ml, 100 ml, 150 ml, and 200 ml of water into each cup. Place a pencil in each cup and draw what you see. Write your discovery about what each pencil looks like in different amounts of water.
3. Using four transparent cups, place 100 ml each of water, vegetable oil, Karo syrup, and alcohol in a cup. Place a pencil in each cup and draw what you see. Write your discovery about what each pencil looks like in liquids of different thicknesses (viscosity).
4. Dry off the pencils and clean up the materials

Enlightening Explorations, Part III

Science Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 2:
Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII-3, VIII-1

Science Standard VI

Objective 2

Connections

Background Information

Visible light is made up of different wavelengths, with each color having its own unique wavelength. The seven colors of the visible light spectrum are red, orange, yellow, green, blue, indigo, and violet (ROY G. BIV). (There is ongoing dissention as to whether indigo is really a color or not. This would make a good student research project.) As light hits an object, some light is absorbed and some is reflected back. The color of an object is the color of the light it reflects. Grass looks green because when light hits, it the blades absorb all the colors of light except green, which it reflects back to our eyes. Objects that appear white reflect back all colors of light waves; black objects absorb all colors of light waves and don't reflect any colors back to our eyes.

White light contains all the colors of light. The colors can be separated when a bright white light is shone through a prism at an angle. Short wavelengths, such as blue and violet, are bent more than longer wavelengths, like red, so the colors always separate into the same pattern. In nature, people have noticed the color separation during or after a rainstorm or from a sprinkler. The primary colors of light are red, green and blue (Roy G Biv's initials), which are different than the primary colors of pigment (yellow, magenta, cyan). Light of all colors can be made from these primary light colors, and when all colors of light are added together, white light is produced.

When colored filters are used, only certain wavelengths pass through; others are absorbed. When a red filter is used over a light, only red light passes through, and objects appear either in shades of red or black.

Materials

Rainbows

For each student:

- ❑ *Rainbow* worksheet (p. 8-28)
- ❑ Book on color and light
- ❑ Light or lamp with bare bulb
- ❑ Diffraction glasses
- ❑ Colored pencils or crayons
- ❑ 1/2 sheet of art paper
- ❑ Paintbrush
- ❑ Red, yellow, and blue watercolors
- ❑ Water

Refraction with Prisms:

- ❑ *Refraction with Prisms* worksheet (p. 8-29)
- ❑ Assorted prisms
- ❑ Bright light (overhead projector or old filmstrip projector)
- ❑ White paper to reflect on

What Color Is it?:

Bagged for the group:

- ❑ Red apple
- ❑ Green leaf
- ❑ Orange
- ❑ Yellow lemon
- ❑ White square of paper
- ❑ Blue square of paper

Per student:

- ❑ Colored lens card
- ❑ *What Color Is It?* worksheet (p. 8-30)

Invitation to Learn

Continue with light labs. You may want to review information already learned.

Instructional Procedures

Continue with light labs. It is important to discuss what was learned in each center when students are finished and have recorded their findings. Like scientists, students share their discoveries and include observable evidence proving what they learned. Allow time for students to challenge each other if a disagreement arises so that the properties of light are understood. Sometimes it takes the final discussion and summarizing of observations before the concept is learned.

Possible Extensions/Adaptations/Integration

- Using *Color Analyzers: Grades 5-8*, make hidden pictures where students can only see the picture if looking through a different colored filter. Make secret messages by writing the message they want someone to see with a blue colored pencil. Using a red pencil, they write letters, numbers, etc. over the blue so the blue message is no longer readable. However, when they look through a red filter, only the blue message appears.
- Have students trace white circles that have pie-shaped divisions on them. Students may experiment with coloring different colors in different fractional amounts to see if they will reflect white or black when spun around. The circle can be taped to the end of one beater of a hand mixer, then the mixer turned on. Students can compare the colors they saw with their prediction.
- Have students use fine-tipped markers (red, yellow, blue, and black) and try pointillist painting, using small dots of these primary colors to create a picture. Students could also use a magnifying glass to look closely at a television screen when it is turned on. They should see lines of very small red, green, and blue dots.
- Students who struggle with written language can be encouraged to draw what they have discovered, then label key things you want them to remember.

Assessment Suggestions

- Have students make a graphic organizer that includes what they know about light and color. Key words to put in the organizer are: energy, electromagnetic spectrum, how light travels, reflection, refraction, and colors of light. Students add what they know about each of these. (This could be a prewriting activity for a reflections paper.)
- Students write a reflections paper containing two to three paragraphs about what they have learned. List several key things you expect them to learn, such as energy, reflection, refraction, angle of incidence, and colors of light.
- After completing the heat, light, and sound lessons, give each student or group a *Heat, Light, and Sound Venn Diagram* (p. 8-33). As they complete it, help them compare the different properties of each, and discover the similarities and differences.

Additional Resources

Books

Light and Color, by Gary Gibson; ISBN 1-56294-616-1

Light Fantastic, by Philip Watson; ISBN 0-688-00975-1

Color Analyzers: Grades 5-8, by Cary Sneider, Alan Gould, Cheryll Hawthorne (GEMS: Great Explorations in Math and Science); ISBN 0-924886-66-8.

Video

Light and Color, by Bill Nye (Disney Educational Productions, 1-800-295-5010, http://dep.disney.go.com/educational/index); Product ID: 68C01VL00

Family Connections

- This Web site is an online kaleidoscope where students can create patterns. http://www.permadi.com/java/spaint/spaint.html
- This is a great Web site with color slides explaining why we see the colors we do. http://whyfiles.larc.nasa.gov/text/kids/Problem_Board/problems/light/sim1.html
- This is a fun interactive Web site where students can mix colors, learn about colors in nature, and have fun exploring with light. http://www.opticsforkids.org/

Name _____

Rainbows

Big ideas from reading:

_____

_____

_____

_____

Look at the light through rainbow glasses. Draw the colors you see as you look at the bulb.

How is this similar to a rainbow?

_____

_____

_____

Using only red, yellow and blue watercolors, paint a rainbow on this page.

Name _____

Refraction with Prisms

Big ideas from reading:

_____

_____

_____

_____

Prism Effect on Light (Refraction)

Draw in detail four discoveries using a prism. Use diagrams.

1. Draw: Discovery: _____

_____

_____

_____

2. Draw: Discovery: _____

_____

_____

_____

3. Draw: Discovery: _____

_____

_____

_____

4. Draw: Discovery: _____

_____

_____

_____

Name _____

What Color Is It?

Place an object on the table. Look at the object through the colored filter then write what color each object appears to be.

Object	Red	Yellow	Green	Blue	Violet
Red apple					
Green leaf					
Orange					
Yellow lemon					
White paper					
Blue paper					

Discover if object is the same color as the filter: _____

_____

_____

Discover if object is the same color as the filter: _____

_____

_____

Discover if object is the same color as the filter: _____

_____

_____

Lab Procedure Cards

Rainbows

1. Read the background information about rainbows. Write at least three sentences explaining how rainbows occur. Include color order from top to bottom.
2. Look at the light bulb through rainbow glasses. Draw the colors exactly as you see them, including the correct width and where they are from the light source.
3. Reflection: compare what you saw through the rainbow glasses to a rainbow. How are they the same and how are they different?
4. Using only red, yellow and blue watercolors, paint a rainbow on the bottom of your page.
5. Clean up and put the paints away when finished.

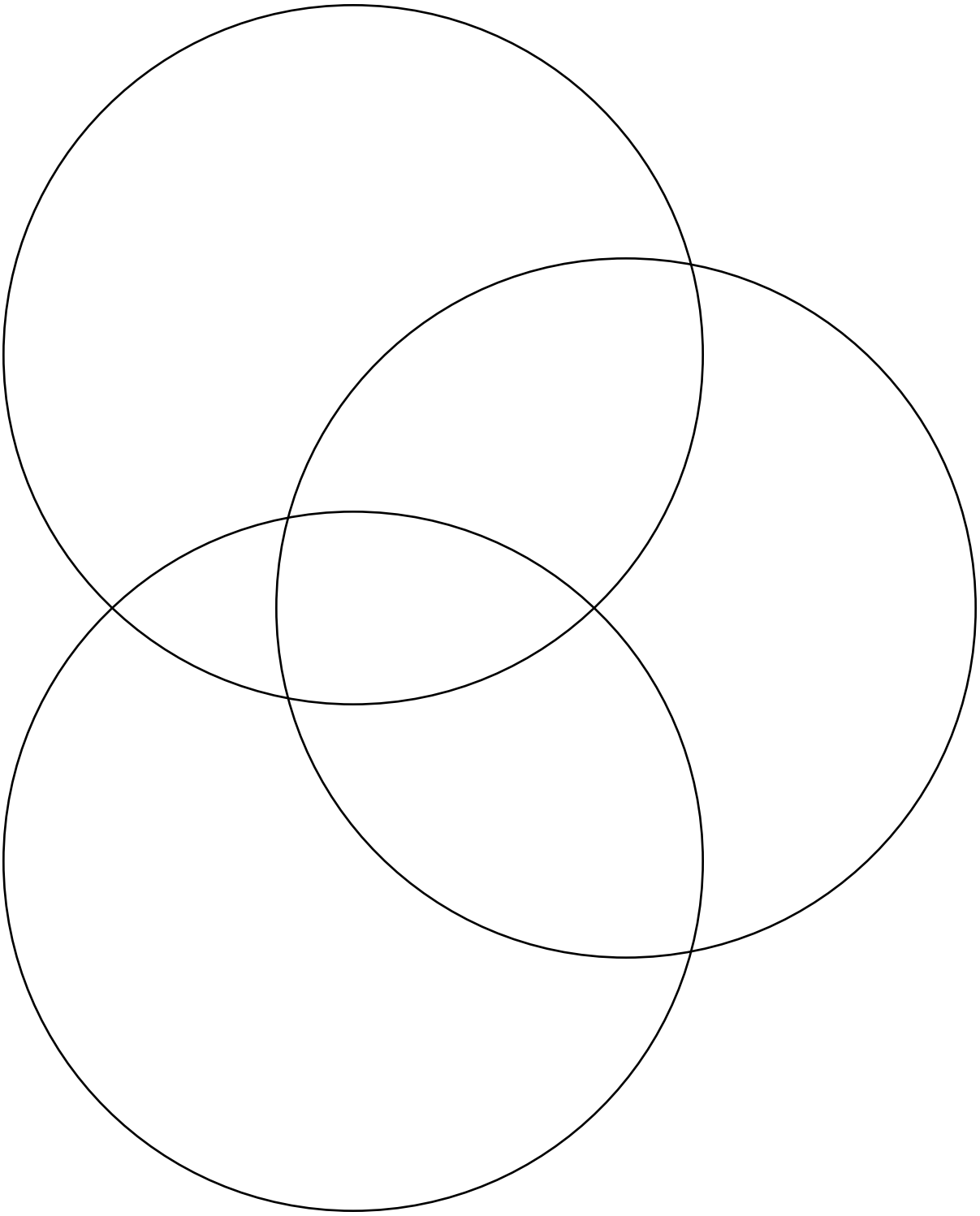
Refraction

1. Read the background information about refraction. Write at least three sentences telling how light is bent.
2. Explore with the prisms Try different ways to get rainbows.
3. **Draw** at least four discoveries on your paper, then **write** what you discovered by each drawing.

What Color Is It?

1. You will be looking at each object in the bag through different colored filters. Make a chart to show each object you looked at, and what it looked like through each colored filter.
2. Use a ruler to make sure the lines of your chart are straight, and use good writing so your chart is readable.
3. Write your discoveries from looking through the colored lenses, and answer the following questions:
   - What if the object was the same color as the filter?
   - What if the object was a different color than the filter?
   - What does white paper look like with each filter?
4. Place the items back in the bag.

Heat, Light, and Sound Venn Diagram



Appendix

Name _____

Design An Experiment: Goldilocks and the Three Bowls

From: Mr./Mrs. _____'s First Grade Class

To: Mr./Mrs. _____'s Sixth Grade Science Class

Dear Students,

Our first grade class recently read *Goldilocks and the Three Bears*. Why did Mama Bear's porridge got cold the fastest? As you remember, Goldilocks didn't like the big bowl of porridge (Papa's) because it was too hot. She also didn't like the middle-sized bowl of porridge (Mama's) because it was too cold. She finally tried the smallest bowl of porridge and said it was just right. Something about the temperature of the porridge just doesn't seem right to me. I am very concerned that I teach my students information that is scientifically accurate. Can your class help me out with this perplexing question?

Thank you,

Procedures

1. **On journal paper**, design a test for the porridge. List each step you will follow. Materials will include: three bowls, three thermometers, porridge, measuring cups, rubber scrapers, safety goggles.
   a. How will you make it a fair test? What will be your variables? Your control?
   b. How much porridge will you put in each bowl?
   c. Where will you put the thermometer? (side, middle, bottom)
   d. How long will you wait after putting the thermometer in the porridge before taking the beginning temperature?
   e. Who will record time?
   f. What is the very best and most accurate way of doing this activity?
   g. Which bowl of porridge do you predict will be the coolest after 12 minutes? Why?
2. **Your teacher will help you get the porridge AFTER you have designed your experiment.**

3. Use the data chart shown below or construct your own.

	Beginning temperature of porridge	Temperature after three minutes	Temperature after six minutes	Temperature after nine minutes	Temperature after 12 minutes
Papa's Bowl					
Mama's Bowl					
Baby Bear's Bowl					

4. Use the conclusions from your data chart to answer the following questions.
   a. Which bowl of porridge cooled off the most by the end of the activity?
   b. Is this what you thought would happen?
   c. Now for the important question: What does this mean in terms of heat?

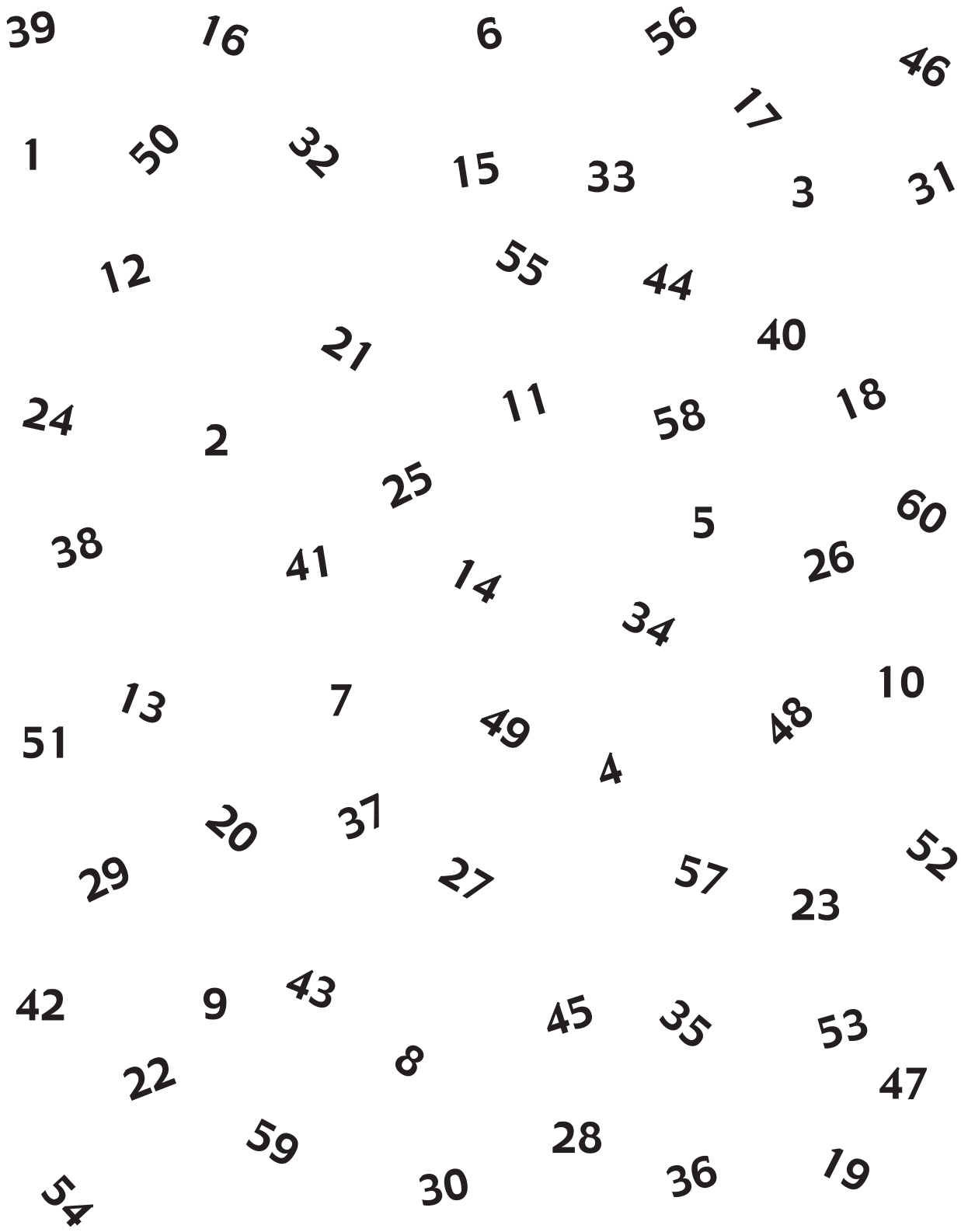
5. Write a letter to the first grade class explaining what you found out and what you think this means for *Goldilocks and the Three Bears*. Make it a fun and interesting letter for them.

   Your letter should include the following:

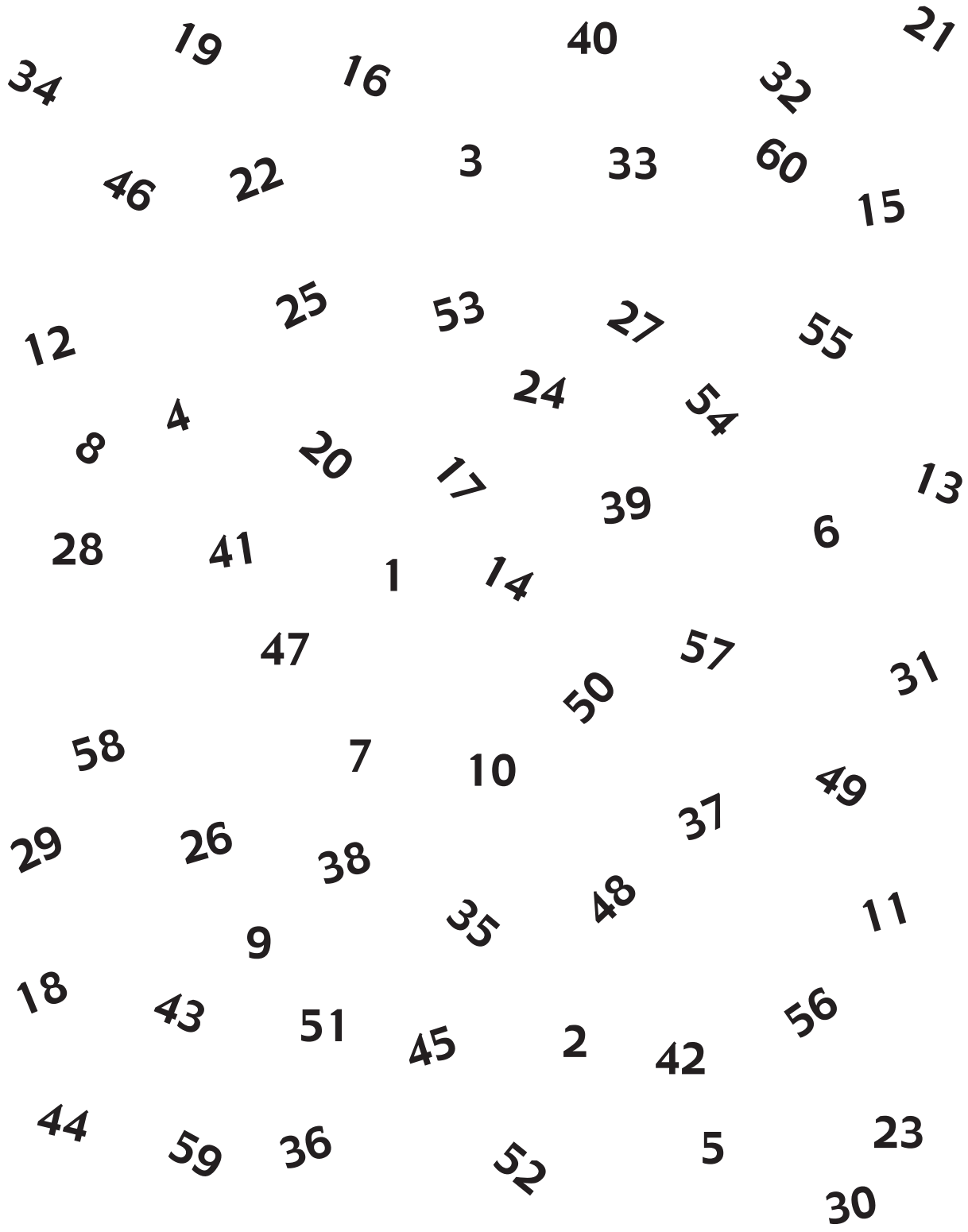
   - Neat printing that first graders can read.
   - Words that first graders can decode and understand.
   - Explanation of the experiment—what was tested?
   - Conclusion/results—what was discovered?
   - Date and greeting (Dear, Hello, Hi).
   - Indented paragraphs with complete sentences.
   - Closing (Sincerely, Yours truly, Thanks).
   - Your name.

6. Have Fun!

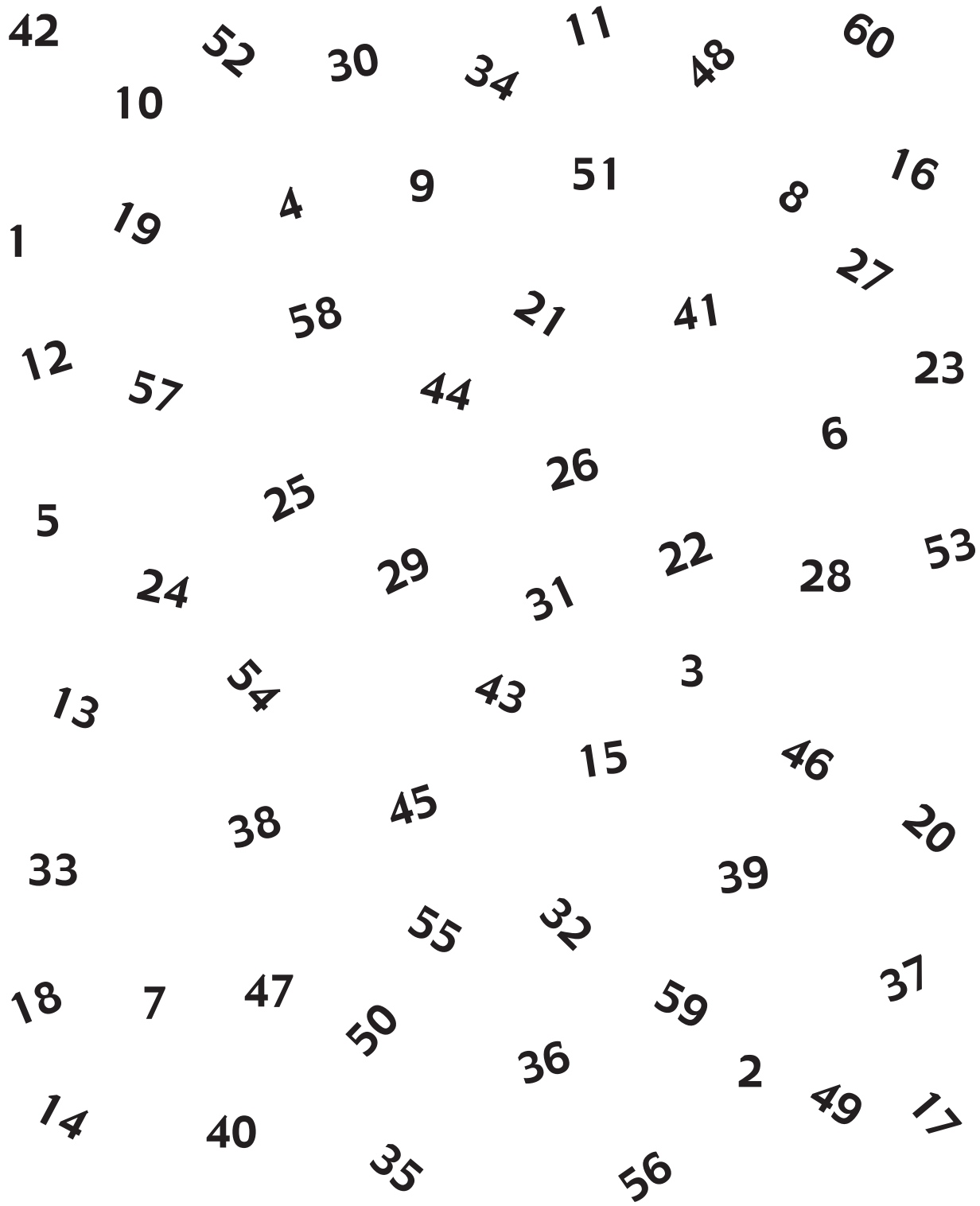
Consecutive Numbers #1



Consecutive Numbers #2



Consecutive Numbers #3



Lunar Language Graphic Organizer

Lunar Language Graphic	Lunar Language Graphic	Lunar Language Graphic
Draw:	**Draw:**	**Draw:**
Description:	**Description:**	**Description:**

Lunar Language Graphic Organizer

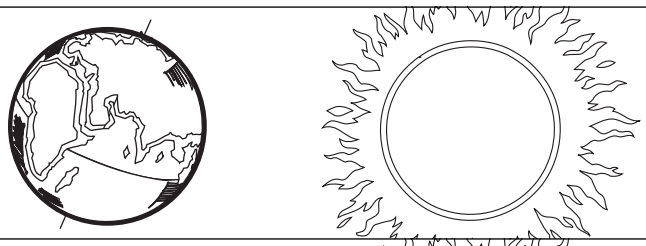
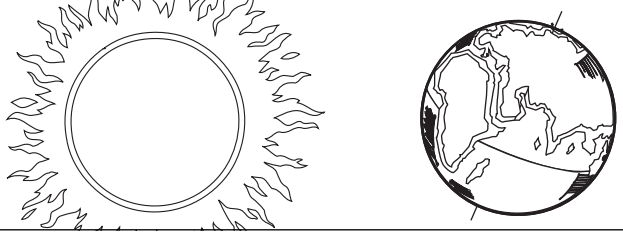
Lunar Language Graphic	Lunar Language Graphic	Lunar Language Graphic
Draw:	**Draw:**	**Draw:**
Description:	**Description:**	**Description:**

Name _____

Guided Notes–Seasons

1. Earth _____ around the _____ in a path that _____ itself every _____.
2. This path is called an _____.
3. Earth's _____ is not straight _____ and _____ but _____ at an angle of _____.
4. The _____ _____ is almost directly above the _____ Pole. Because of this the _____ _____ always stays in the _____ _____ in the sky. _____ the other _____ seem to revolve around the _____ _____.
5. This means that Earth's _____ _____ _____ always points in the _____ _____ while it revolves around the sun.
6. Because of this the _____ hemisphere is tilted towards the sun around the _____. The _____ hemisphere is tilted towards the sun about the _____.
7. When the Northern hemisphere has _____ the southern hemisphere has _____. When the northern hemisphere has _____ the southern hemisphere has _____.
8. When the northern hemisphere is tilted _____ from the sun in _____, the _____ appears _____ in the sky. The angle of the _____ hitting Earth is _____. This means that the northern hemisphere receives _____ _____ from the sun.
9. When the northern hemisphere is tilted _____ the sun in _____, the _____ appears _____ in the sky. The angle of the _____ hitting Earth is _____. This means that the northern hemisphere receives _____ _____ from the sun.
10. In summer the sun is _____ _____ and the _____ are _____. This gives the sun plenty of time to _____ Earth.
11. In the winter the sun is _____ _____ and the _____ are _____. This gives the sun little time to _____ Earth.
12. The two reasons that we have seasons are:
    1._____
    2._____

In the diagram below, label the picture that shows when it is summer in Utah, “Summer;” and the picture that shows when it is winter in Utah, “Winter.”

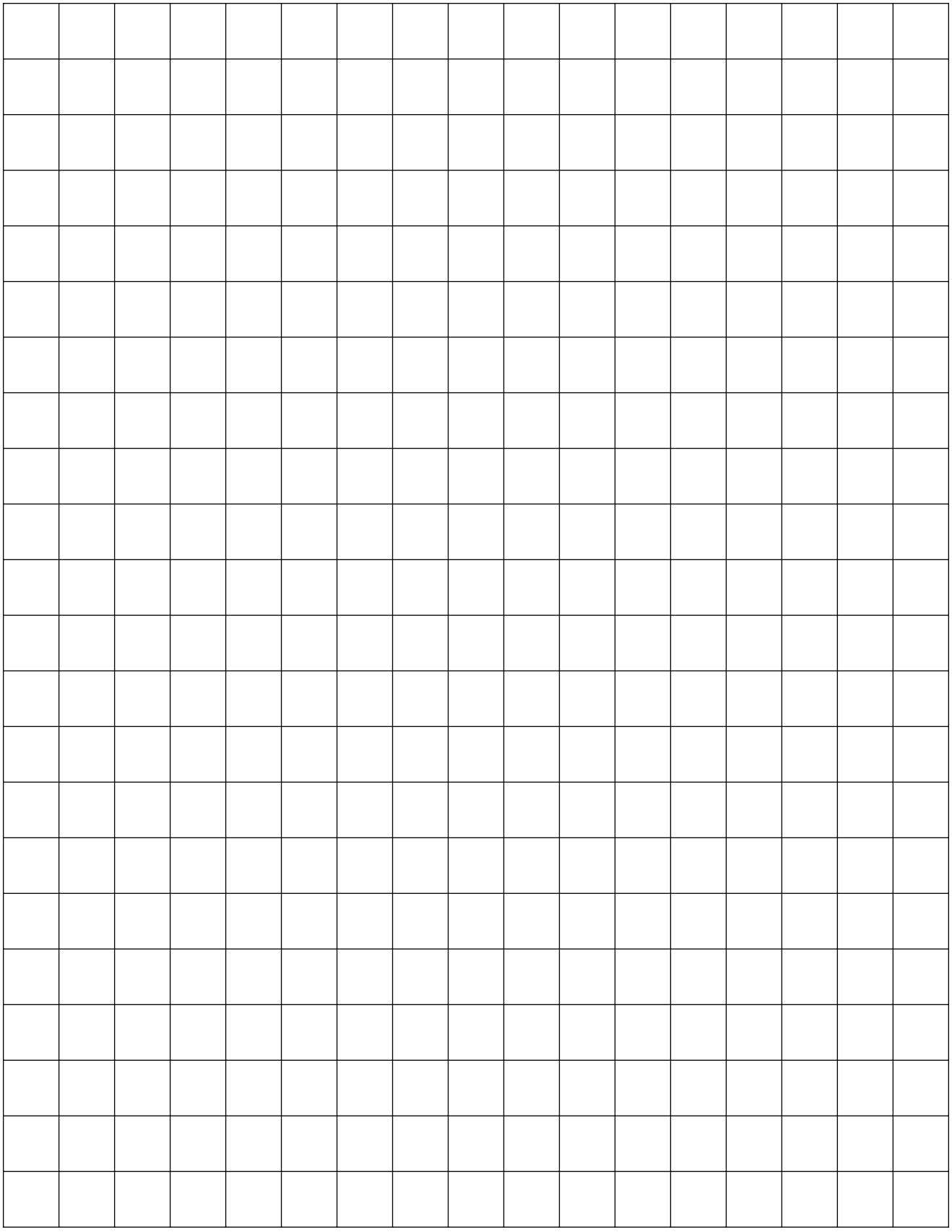
Example A _____	
Example B _____	

Seasons Vocabulary Cards

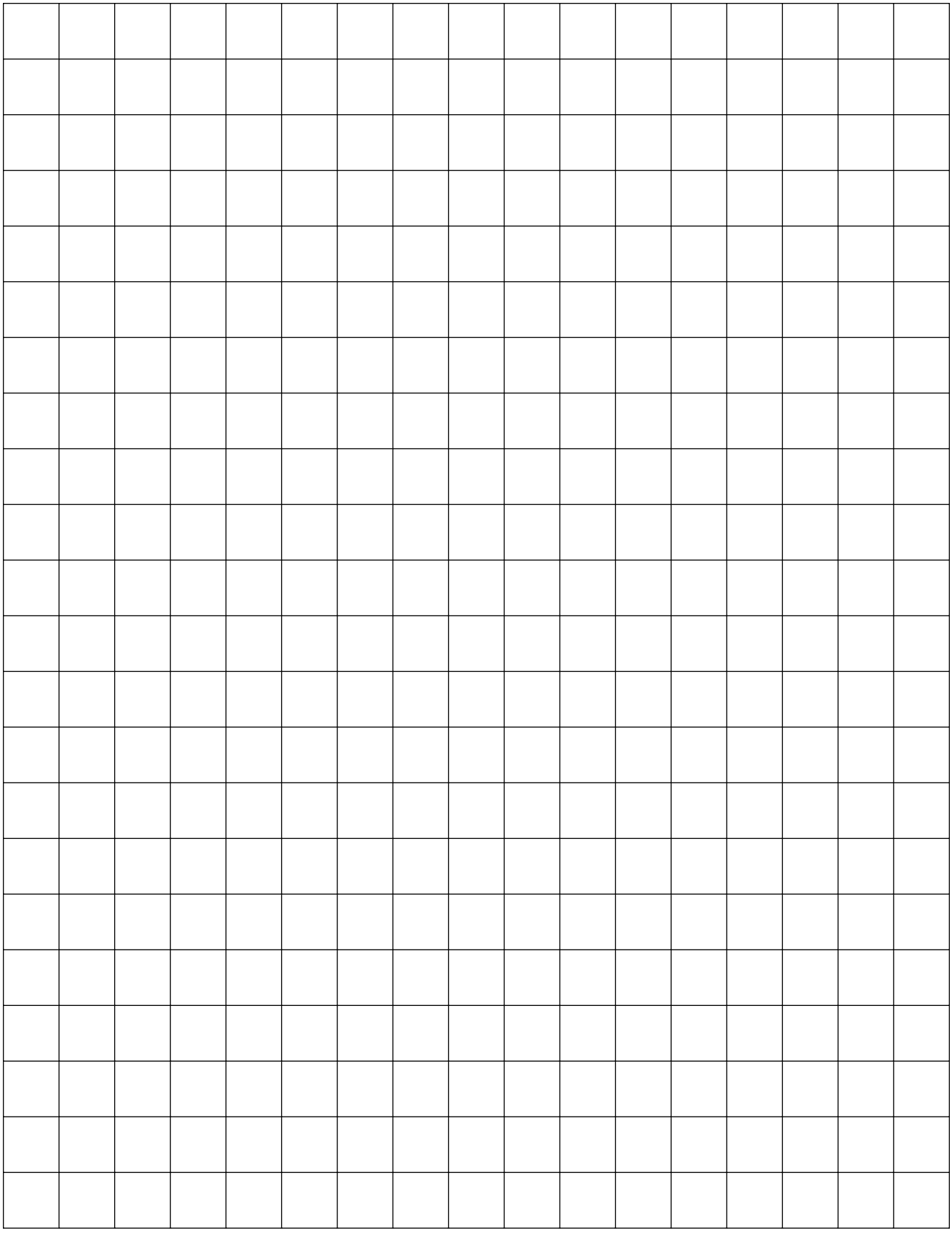
1. An imaginary line going from the north pole to the south pole. Earth spins on this line.	2. Earth's axis is not straight up and down, instead it leans at a 23.5° angle	3. The path that a planet travels as it goes around the sun.	4. The changes in the appearance of the moon's shape during a month.
5. We see all of the lit side of the moon. Earth is between the sun and the moon.	6. The moon has moved one-quarter of the way around Earth.	7. We cannot see the moon. The moon is between Earth and the sun.	8. The moon has moved three quarters of the way around Earth.
9. The bouncing of light off of an object. The moon appears to shine because of the sun's light.	10. The circling of one object around another object in space. A planet moves around the sun. A moon orbits around a planet.	11. When a planet or moon spins on its axis.	12. Due to the tilt of Earth as it travels around the sun, we have spring, summer, fall, and winter.

4. Phases of the moon	3. Orbit	8. Last quarter
2. Earth's tilt	7. New moon	12. seasons
6. First quarter	11. Rotation	10. Revolution
1. Axis of rotation	5. Full moon	9. Reflection

Centimeter Grid



Centimeter Grid



Name _____

How Light Travels

Big ideas from reading:

_____

_____

_____

_____

_____

_____

Place each item in the bag between the flashlight and a white board to determine what happens when light hits that object. List four examples of each.

- Objects that *allow light* to pass through are: _____

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

- Objects that *allow some light* to pass through are: _____

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

- Objects that *block all light* are:

  Draw:

  1. _____
  2. _____
  3. _____
  4. _____

Name _____

Comparing Light Sources

Compare light sources to determine the differences in light.

Light Source	Color	Intensity (how bright)	Direction Light Travels	Temp. Change
Flashlight #1				
Flashlight #2				
Flashlight #3				
Incandescent Bulb				
Flourescent Bulb				
Laser Pen				

Choose a situation card from the teacher and describe which light you would use for that situation. Write **three** justifications for your choice.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____

Reflective Surfaces

1. Set a square of foil on the desk in front of you. Use a light and reflect it up to the ceiling.

   Do you get a good reflection? _____

   Why? _____

   _____

   _____

2. Crumple the foil square, then straighten it out. Use the light and reflect it up to the ceiling.

   Do you get a good reflection? _____

   Why? _____

   _____

   _____

3. Compare both of these to the reflection of the sky on the lake.

   _____

   _____

   Describe the reflection you see when shining a laser light on each of the following objects. Note the size of the reflection: larger, smaller, none.

sandpaper	**white paper**	**black paper**
stiff plastic	**metal**	**glass**

Discovery: _____

_____

_____

_____

Name _____

Light

Angle of incidence is the angle at which light hits an object. Place a mirror at the edge of the protractor (reflective edge of mirror must be on the 0 line). Use a laser pointer to shine a light from one angle of the protractor and determine at which angle it is being reflected.

Angle of Incidence	**20°**	**60°**	**80°**	**40°**	**70°**	**10°**	**50°**	**30°**
Angle of Reflection								

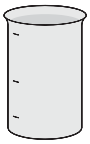
Name _____

Refraction

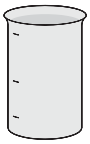
Refraction: Light travels in straight lines called rays at 186,000 mps or 3000,000 km/sec. When light passes through a transparent object at an angle, it slows down. The light waves slow down one by one, bending the light. This is Refraction.

1. Reappearing coin (draw the cup, coin, and angle of light)

Before adding water



After adding water



Discovery: _____

_____

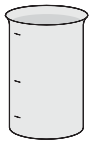
Conclusion: _____

_____

2. Broken Pencils

50ml

100ml



150ml

200ml

Discovery: _____

_____

Conclusion: _____

_____

3. Viscous liquids

Water

Veg. Oil

Karo Syrup

Alcohol

Discovery: _____

_____

Conclusion: _____

_____

Reflections–6th Grade

Expository Writing and Evaluating

Standard V–Microorganisms

Standard I–Phases of the Moon

Standard II–Earth's Axis and Seasons

Standard VI–Heat and Sound

Standard VI–Light